Whitewings®

- ASSEMBLY INSTRUCTIONS
- FLIGHT INSTRUCTIONS
- GUIDELINE FOR WHITEWINGS
- INTRODUCTION TO PAPER PLANE DESIGN
- HOW TO BUILD "WHITEWINGS"

HERITAGE SERIES

Flight through the sky has long captivated men's imaginations. Today, air travel has become as simple for the average person as boarding a jumbo commercial airliner. If, however, we really want to experience, at first hand, the "joy of flight", I believe it's far more exciting to fly a miniature plane that you've made by your own efforts or to soar through the air on a hang glider. So that as many people as possible may readily get a taste of this fascinating experience, I would like to highly recommend that you make and fly your own paper airplanes.

Challenge the sky with Whitewings

When you hear the word "paper airplane" you may think of a child's folded plane made of a piece of paper. If you use a somewhat thicker and better quality paper, and cut and glue several layers of paper together, you can design and build aerodynamically and structurally high-performance paper planes. The Whitewings "Heritage Series" 15 model kit includes racer models featuring MOST wings, easily assembled light plane models, profile models of well-known planes, and three new models featuring the triangular long fuselage. I call these new planes "TriLinear" models. These TriLinear models offer unimaginable flight performance. All the parts are printed on excellent quality drawing paper so you need only a minimum of tools such as scissors and glue. You can easily build a plane with excellent flying capability. The completed Whitewings will fly much better than you probably ever imagined a paper plane could fly. In order to maximize the Whitewings flying performance, you must follow the points listed below.

- Read the instructions carefully and thoroughly.
- Apply sufficient glue over the entire surface of the part to ensure a sturdy plane.
- After the plane is assembled, make sure that the glue is completely dry. (Allow at least one day.)

Learning how to fly your paper plane is of primary importance. It is as important as building the plane.

- Test fly repeatedly until you can make your plane fly smoothly and straight forward.
- And then practice making it fly to a high altitude.

You should practice the above steps with care and patience.

Also, when you fly your plane, it will be important to remember the following:

- **Fly your planes in a big, open space, away from people who might get hit.**
- **Make sure you are in an area where there are no passing cars.**

DON'T FORGET THESE PRECAUTIONS!

So, now you're ready to give it a try.
Take-off, WHITEWINGS!

Yasuaki Ninomiya

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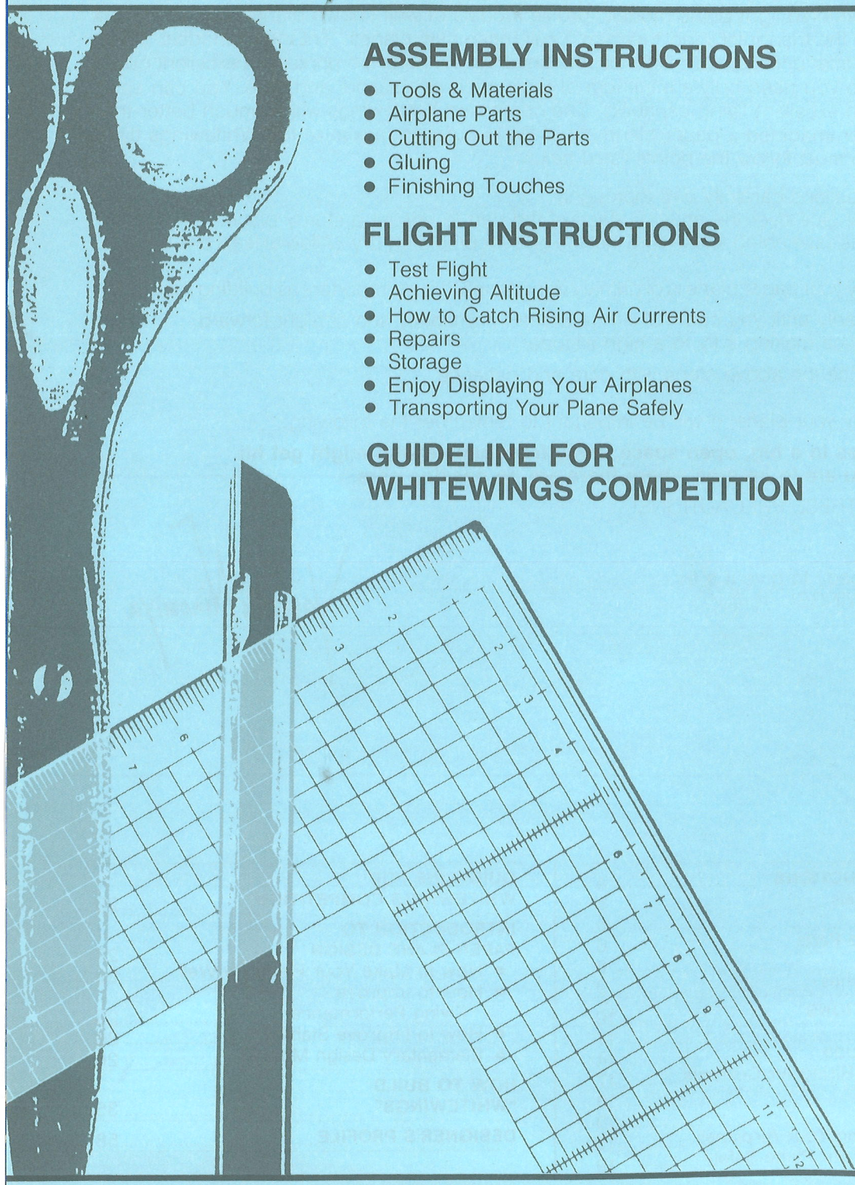

ASSEMBLY INSTRUCTIONS

- Tools & Materials
- Airplane Parts
- Cutting Out the Parts
- Gluing
- Finishing Touches

FLIGHT INSTRUCTIONS

- Test Flight
- Achieving Altitude
- How to Catch Rising Air Currents
- Repairs
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- Enjoy Displaying Your Airplanes
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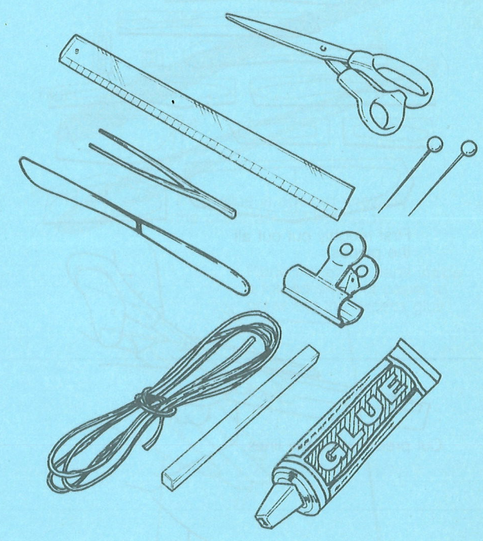
GUIDELINE FOR WHITEWINGS COMPETITION

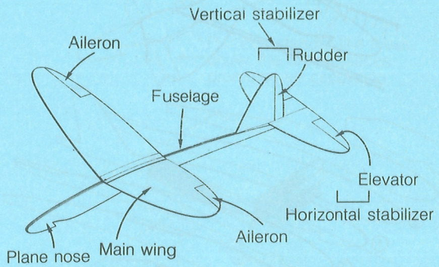
TOOLS & MATERIALS

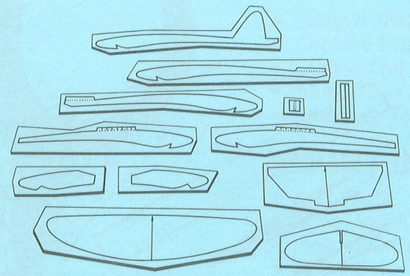
- **SCISSORS:** A pair of scissors that cuts well (Dressmaker's or tailor's are excellent).
- **RULER:** Used to fold pieces and make creases accurately.
- **COMMON ORDINARY TABLE KNIFE:** Used for making the creases in the triangular long fuselage.
- **CLIPS:** Approximately ten clips are required for the construction of the triangular long fuselage. Clothespins may be used in place of clips.
- **TWEEZERS:** Used for checking the center of gravity and assembling the smaller pieces.
- **GLUE:** A clear, fast drying glue is most suitable; for instance, Dupont's "Duco Cement", Allen Products Corporation's "Seal All" or Bond Corporation's "527 Cement". These can be bought at your local drugstore, hardware, or stationery store.
- **RUBBER BAND AND ROD:** Used for making a rubber band catapult.
- **STRAIGHT PIN:** Used for making pin holes.



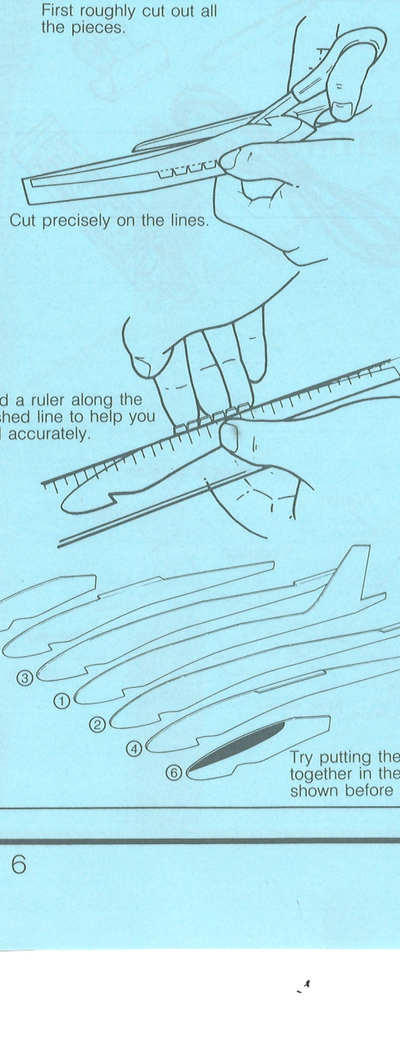
AIRPLANE PARTS

Figure shows a plane's parts and what they are called.



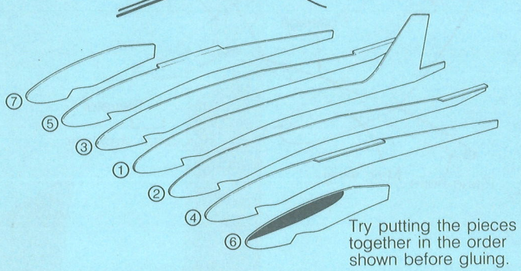


First roughly cut out all the pieces.



Cut precisely on the lines.

Hold a ruler along the dashed line to help you fold accurately.



Try putting the pieces together in the order shown before gluing.

CUTTING OUT THE PARTS

Roughly cut out each piece taking care not to cut into adjacent pieces.

Trim each piece to size by cutting precisely on the line. However, don't cut on the lines of the front and back of the main wing backing. Leave a 2-3 mm margin on these edges, as described in the gluing instructions.

Bend the tabs for the main wing and stabilizer before gluing the fuselage (plane body) together. Bend the tabs along the dashed lines using a ruler to make sure that tabs are neatly folded.

GLUING

Try putting the pieces together before gluing, according to the gluing instructions and explanatory figures for each model, to make sure everything is ready and in order.

After all the details have been satisfactorily worked out, you are now ready for the actual gluing. Following the gluing instructions precisely, glue the pieces together in the proper order.
(Note: To build a straight solid body, first glue ①, ② and ③ together and let dry on a flat surface. Then glue the rest of the body parts, in order, to this center section.)

Apply the glue evenly and quickly, making sure that the assembled pieces do not slip out of position.

If the glue is insufficient, the pieces will not be firmly glued together, resulting in weak construction and poor flying performance.

In order to assemble a sturdy fuselage, after gluing on each piece, place the assembled pieces inside a folded piece of scrap paper and press out the excess glue with your fingers. Gradually assemble the fuselage piece by piece in this fashion, taking care that none of the pieces have slipped out of place, and that each one is in its proper position.

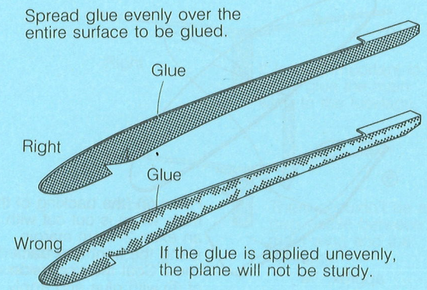
Use a blank piece of scrap paper and make sure that no print on the paper comes into contact with the glued parts. Since glue has the power to dissolve printing ink, the ink could smear onto the assembled plane.

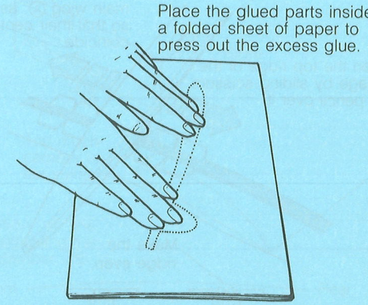
Spread several layers of large scrap paper over a desk or other flat surface for protection. Set the newly glued main wing and fuselage on the papers to dry for at least 5–6 hours.

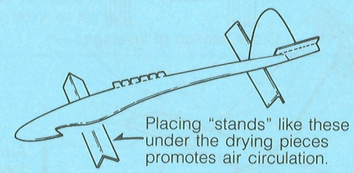
Or, for speedier drying, place "stands" of folded paper under the glued parts as shown in the figure. This permits improved air circulation to the underside of the glued parts.

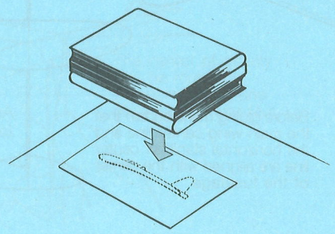
When building a layered fuselage, it is helpful to place books on top of the fuselage as a weight after gluing in order to maintain a solid and uniform body.

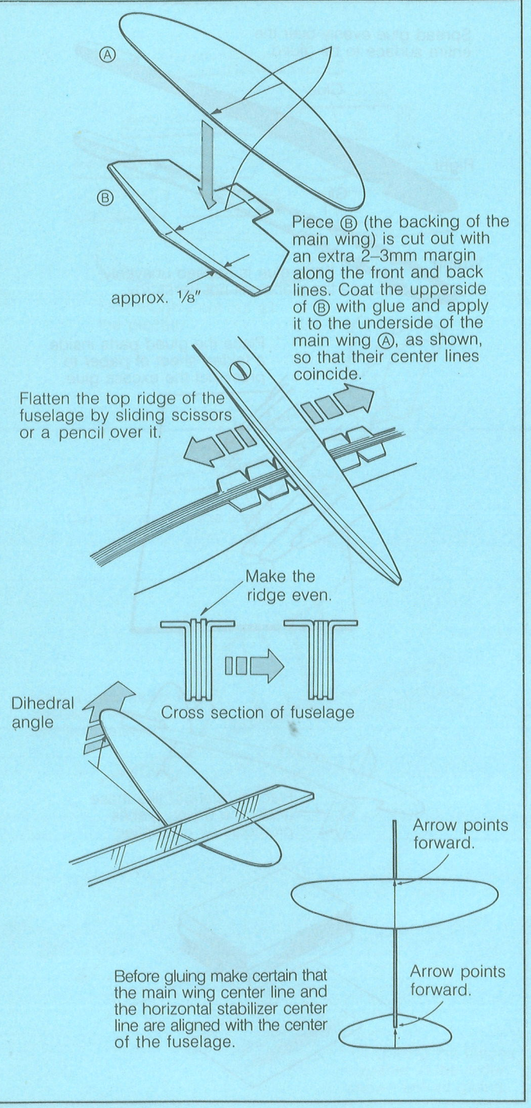
The assembly instructions for the triangular long fuselage are located on pages 43 and 44.


Spread glue evenly over the entire surface to be glued.
Glue
Right
Glue
Wrong
If the glue is applied unevenly, the plane will not be sturdy.








Ⓐ
Ⓑ
approx. 1/8″
Piece Ⓑ (the backing of the main wing) is cut out with an extra 2–3mm margin along the front and back lines. Coat the upperside of Ⓑ with glue and apply it to the underside of the main wing Ⓐ, as shown, so that their center lines coincide.
Flatten the top ridge of the fuselage by sliding scissors or a pencil over it.
Make the ridge even.
Cross section of fuselage
Dihedral angle
Arrow points forward.
Arrow points forward.
Before gluing make certain that the main wing center line and the horizontal stabilizer center line are aligned with the center of the fuselage.

When "assembling the main wing" is mentioned, we are referring to gluing the reinforcement piece Ⓑ to the main wing Ⓐ.

The center line for piece Ⓑ extends about 3 mm (1/8″) in front and in back of the cutting lines. When cutting out piece Ⓑ, you will notice in the figure that the left and right edges are cut right on the lines, but the front and back edges extend 2–3 mm outside the lines. Apply glue evenly to the upper surface of piece Ⓑ, and gently fit piece Ⓐ on top of piece Ⓑ. Because piece Ⓑ's center line extends out from the front and back of piece Ⓐ, it is easy to line up the center lines of pieces Ⓐ and Ⓑ accurately. After the glue is dry, you can cut off the protruding portions of piece Ⓑ.

In order to glue the main wing precisely and securely to the body, the part of the fuselage to which it will be glued must be smoothed flat with scissors or a pencil, before applying the glue, as shown in the figure.

Place a ruler along the center line of the main wing, and bend the wing slightly upward (called a dihedral angle) as shown in the figure. Since the dihedral angles vary from model to model, bend the wing upward until the angle is identical to the angle indicated in the assembly instructions for that particular model.

When gluing the main wing and horizontal stabilizer to the fuselage, make sure that the center line is properly aligned lengthwise with the center of the fuselage. You will find that if you glue the stabilizer onto the fuselage before gluing the main wing onto the fuselage, assembly will be much easier.

The importance of gluing the main wing firmly to the fuselage cannot be overemphasized. In order not to leave any gap between the main wing and the body, press down firmly on the center of the main wing about 5–6 minutes after gluing. After gluing the main wing and stabilizer onto the fuselage, let it dry thoroughly for 3–4 hours.

FINISHING TOUCHES

To make a truly high performance plane, it is important that the cross section of the main wing be curved in such a fashion as to minimize drag, or air resistance, and maximize lift, the upward draft of air.

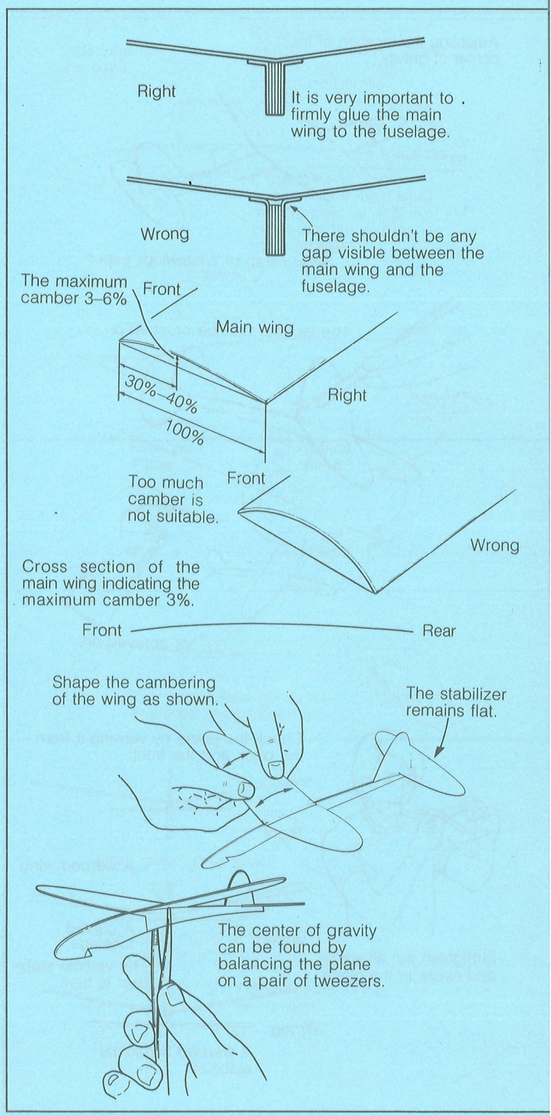
To make the proper curve, bend the main wing slightly in the manner shown in the figure (this is called cambering the wing). This shape is necessary for top performance.

Use the figure on the right as a guide to give an appropriate camber to the main wing.
The maximum camber point should be between a distance of 30% and 40% from the front edge of the main wing.

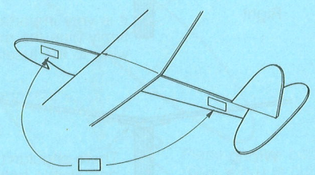
Only the main wing is to be cambered. The stabilizer should be left flat.

Placing the dihedral angle gauge on the middle of the wing, once again make sure that the dihedral angle is the required one.

To test to see if the center of gravity is properly aligned or not, take an open pair of scissors or tweezers and balance the plane on the two tips at the ▲ mark as shown in the figure.
All of the planes in the Heritage Series are designed to have the center of gravity located at the ▲ mark. In some cases, however, due to an excess of glue or lacquer on the plane, you may find that the center of gravity is not

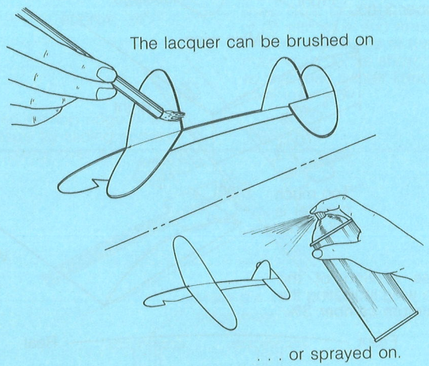

Right
It is very important to firmly glue the main wing to the fuselage.
Wrong
There shouldn't be any gap visible between the main wing and the fuselage.
The maximum camber 3–6%
Front
Main wing
30%–40%
100%
Right
Too much camber is not suitable.
Front
Wrong
Cross section of the main wing indicating the maximum camber 3%.
Front
Rear
Shape the cambering of the wing as shown.
The stabilizer remains flat.
The center of gravity can be found by balancing the plane on a pair of tweezers.

Adjusting the location of the center of gravity.



Small scrap of Whitewings paper

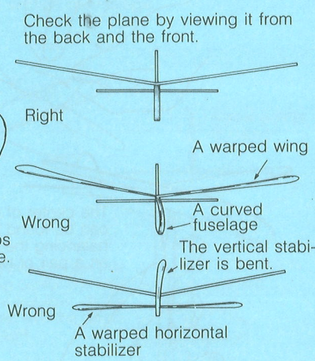
The lacquer can be brushed on



. . . or sprayed on.

Straighten out all warps and twists in the plane.

Check the plane by viewing it from the back and the front.



properly located at the ▲ mark. When this happens, it becomes necessary to add some additional weight. To do so, attach a small scrap of the remaining Whitewings paper lightly to either side of the plane nose or the rear of the fuselage and secure it temporarily with a small amount of glue. Vary the position or size of the attached paper until the center of gravity is located properly and then glue the attached paper firmly to the fuselage. The center of gravity should be located within 1 mm (1/24″) of the ▲ mark.

If your paper plane is coated with lacquer, it will become water resistant. Therefore when it lands on wet grass, if you quickly wipe the water off with a soft cloth, you're ready for another flight. For preserving the beauty of the white paper, clear lacquer is good, but if you want your plane to be a different color, you can use colored lacquer. It doesn't matter whether you spray it on or paint it on with a brush, but in order to keep the plane light and preserve its balance and center of gravity, be careful to coat the plane as thinly and evenly as possible.

FLIGHT INSTRUCTIONS

One of the secrets of flying a paper plane well is to view the plane closely from a head-on position and straighten out all warps, bends or twists with your fingers.

Inspect your plane thoroughly from the front:

(1) Is the fuselage bent?
(2) Are both the right and left main wings straight, perfectly matched, and are both inclined at the same angle?
(3) Is the horizontal stabilizer warped or bent?
(4) Is the vertical stabilizer warped or bent?

Check for these irregularities and straighten out any bent or warped areas gently and carefully.

Inspect your plane from the rear and check for irregularities in the same manner as above.

Check the plane from both sides also.

- Do the inclinations of both the near and far wing tips match?

If they don't, this is proof that the main wing is warped, so straighten it out with your fingers until the wing tips line up perfectly.

TEST FLIGHT

The reason most model airplanes don't fly well is that they have not been properly adjusted. After finishing your plane, the importance of following the test flight and adjustment instructions carefully cannot be overemphasized!!

If you continuously repeat the test flight and adjustment procedures, adjusting your plane slowly but surely, you will finally arrive at a point where your plane will always glide smoothly and in a straight line. A perfect flight every time!

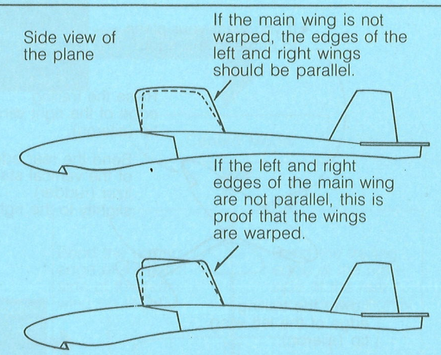
Try to test fly your plane when there is as little wind as possible. If there is a breeze, always throw your plane straight into the wind. When test flying your plane indoors, always try to throw it toward a curtain to ensure safety.
Do not throw the plane upward. Aim it horizontally or slightly downward and toss it gently forward to make the plane glide smoothly.

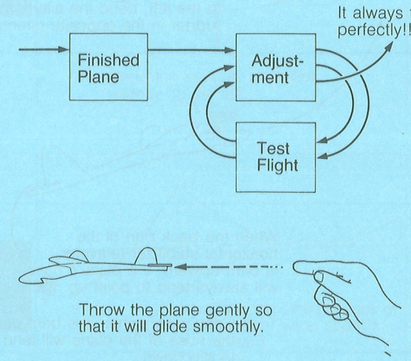
How to adjust your plane:

- When it curves to the left or right
- When the nose goes up or down

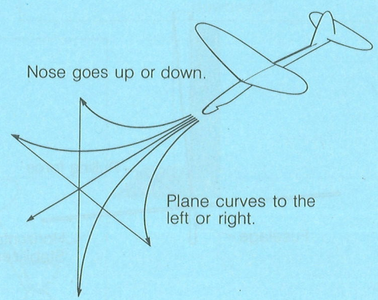
If you know how to adjust your plane to correct these two faults, your plane will be able to fly well. I will explain how to correct each of these faults with the proper adjustment.

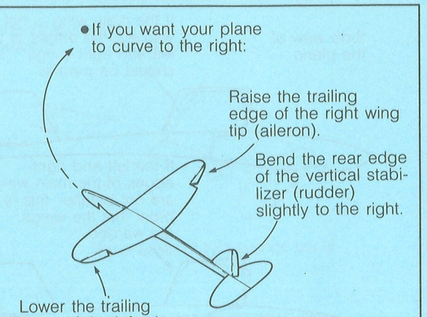
Side view of the plane


If the main wing is not warped, the edges of the left and right wings should be parallel.
If the left and right edges of the main wing are not parallel, this is proof that the wings are warped.

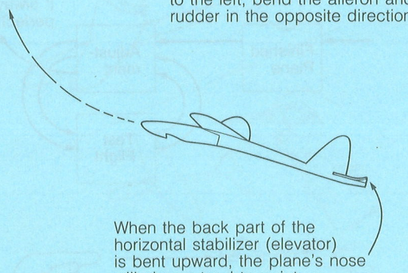


Throw the plane gently so that it will glide smoothly.

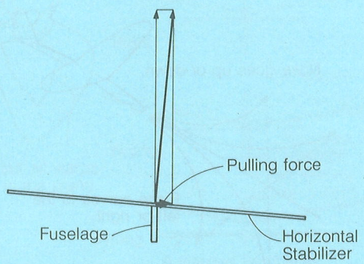



●If you want your plane to curve to the right:
Raise the trailing edge of the right wing tip (aileron).
Bend the rear edge of the vertical stabilizer (rudder) slightly to the right.
Lower the trailing edge of the left wing tip (aileron).

●If you want your plane to curve to the left, bend the aileron and rudder in the opposite direction.



●Conversely, when it is bent down, the nose of the plane will tend to dip down.



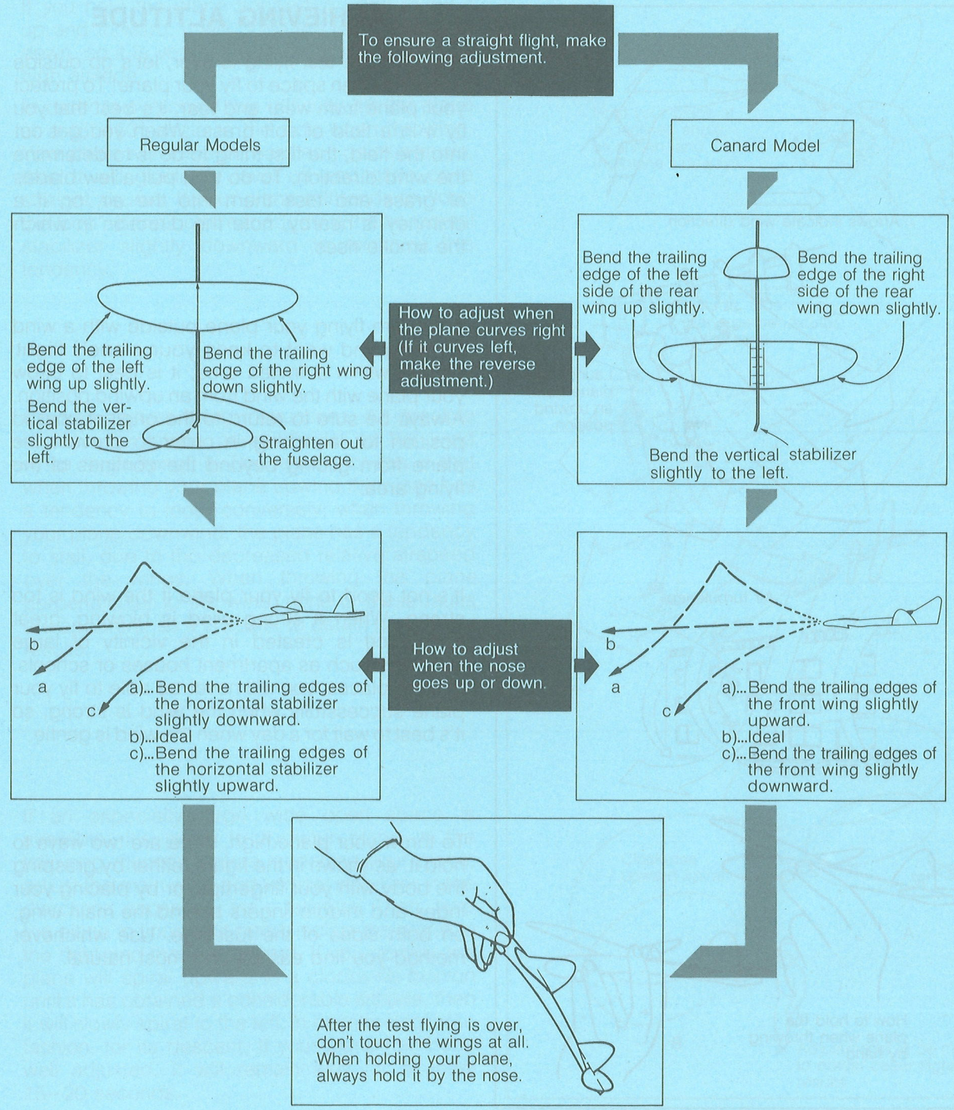
The first thing to look for when test flying your plane is whether it flies to the left or right. If so, perform the following adjustments and your plane will fly straight.

If a paper plane curves to the left or right, it is always because there is a bend or a warp somewhere on the plane. Therefore, the first step is to examine the plane again thoroughly, and straighten out the affected parts with utmost care. If the plane still curves to the left or right, bend the trailing edges of the wing tips (ailerons) and vertical stabilizer (rudder) in the appropriate directions, according to the instructions in the figure on page 13, in order to correct this fault and ensure straight flight.

The second thing to test for is to see whether or not the nose gradually goes up and the plane loses speed; also watch if the plane's nose rises up, then suddenly dips down. This is known as stalling. If the glider does this, a smooth flight pattern can be assured by adjusting the back ends of the horizontal stabilizer (elevators).

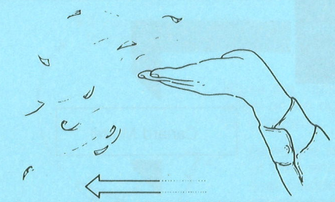
When flying your plane outdoors, if you want to make your plane curve to either direction, you can do this by bending the ailerons and rudder, as shown in the top figure. **(It's not necessary to make incisions in the wings; just bend the appropriate areas slightly with your fingers to adjust the ailerons and rudder.)**

Alternatively, you can tilt the horizontal stabilizer. This is because the planes in this kit are designed so that they have lifting force in the horizontal stabilizer as shown in the accompanying figure. Therefore, if you tilt the horizontal stabilizer to the right, the pulling force to the right as shown causes the nose of the plane to curve left.

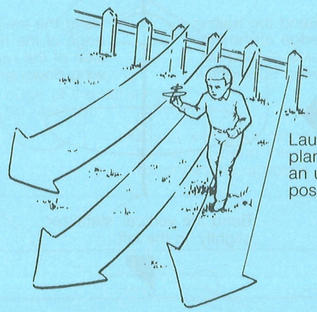

To ensure a straight flight, make the following adjustment.
Regular Models
Canard Model
Bend the trailing edge of the left wing up slightly.
Bend the trailing edge of the right wing down slightly.
Bend the vertical stabilizer slightly to the left.
Straighten out the fuselage.
How to adjust when the plane curves right (If it curves left, make the reverse adjustment.)
Bend the trailing edge of the left side of the rear wing up slightly.
Bend the trailing edge of the right side of the rear wing down slightly.
Bend the vertical stabilizer slightly to the left.
b
a
c
a)...Bend the trailing edges of the horizontal stabilizer slightly downward.
b)...Ideal
c)...Bend the trailing edges of the horizontal stabilizer slightly upward.
How to adjust when the nose goes up or down.
b
a
c
a)...Bend the trailing edges of the front wing slightly upward.
b)...Ideal
c)...Bend the trailing edges of the front wing slightly downward.
After the test flying is over, don't touch the wings at all. When holding your plane, always hold it by the nose.

Whitewings

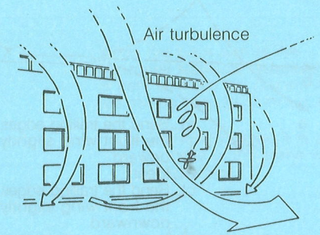
FLIGHT INSTRUCTIONS



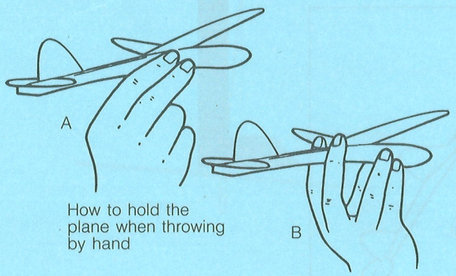
Arrows indicate wind direction.



Launch the plane from an upwind position.



Air turbulence



How to hold the plane when throwing by hand

ACHIEVING ALTITUDE

Now that the test flying is over, let's go outside to a wide open space to fly your plane! To protect your plane from wear and tear, it's best that you fly it in a field of soft grass. When you get out into the field, the first thing to do is to determine the wind direction. To do this, pull a few blades of grass and toss them into the air, or, if a chimney is nearby, note the direction in which the smoke rises.

If you are flying your plane outside with a wind blowing and want to keep your plane's flight pattern within a limited area, it is best to throw your plane with the wind from an upwind position. Always be sure to return to the original upwind position for launching in order to prevent the plane from gliding beyond the confines of the flying area.

It's not good to fly your plane if the wind is too strong. When a strong wind is blowing, great turbulence is created in the vicinity of large buildings such as apartment houses or schools. In such places, you will never be able to fly your plane successfully when the wind is strong, so it's best to wait for a day when the wind is gentle.

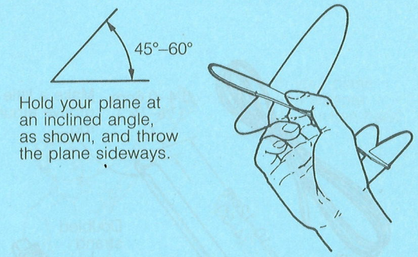
To throw your plane high, there are two ways to hold it, as shown in the figure, either by grasping the body with your fingertips, or by placing your index and middle fingers behind the main wing, on both sides of the fuselage. Use whichever method you find easiest and most natural.

If you hold the plane horizontally, and throw it up and forward, it will "loop the loop" and dive down, so it is very difficult to get it to glide at a high altitude.

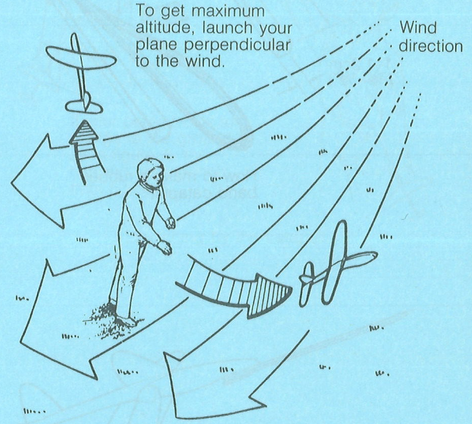
In order to overcome this difficulty, tilt the plane at a 45°–60° angle to the side when throwing. Your plane will curve outward as it gains altitude, then it will gradually level off and glide on a straight course. If your plane still tends to "loop the loop", bend both rear edges of the horizontal stabilizer slightly downward to minimize this tendency.

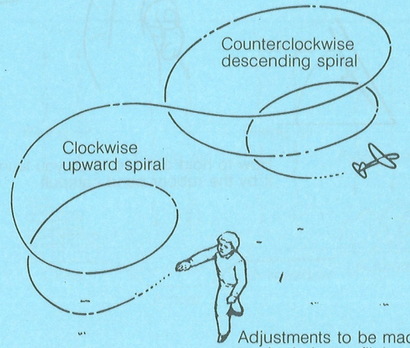
Contrary to test flying instructions, it's great to launch your plane perpendicular to the wind when "high-flying" it. The reason for this is that when throwing your plane upwind the plane has a tendency to loop; conversely, when throwing your plane downwind, the plane has a tendency to stall, due to the decreased relative airspeed over the wings. When throwing the plane perpendicular to the wind, none of these faults are apparent, so it is easier to obtain good flight results.

If an especially large wide open space is available, it's good to fly your plane in the following manner: before launching your plane, adjust the main wing and vertical stabilizer in the directions necessary for a left turn. Then, take the plane in your right hand, incline the plane to the right and throw it upward. If you do this, the plane will spiral upward in a clockwise fashion until it has obtained a considerable altitude, then it will slowly spiral to the left, in counterclockwise fashion, for its descent. If your plane has been well adjusted, it will remain aloft for at least 15–20 seconds.

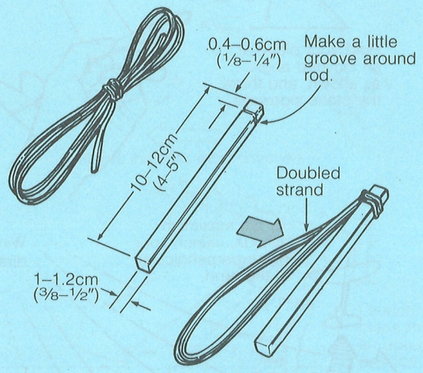


Hold your plane at an inclined angle, as shown, and throw the plane sideways.

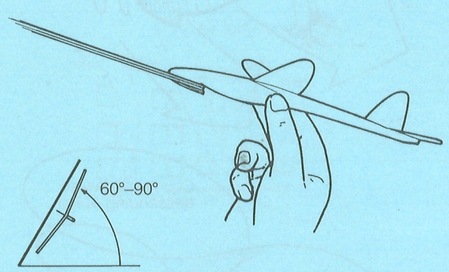




Adjustments to be made to obtain better flight results



How to make a rubber band catapult



How to hold a plane when you launch it by the rubber band catapult

If you use a rubber band catapult, you will be able to fly your plane at a high altitude for a long time. Another advantage of using the catapult is its ability to maintain the desired position of the plane, as at launching, and thereby ensure a proper flight course.

A catapult can be made easily from the included wooden rod and rubber band. Make a groove at the place shown in the figure and fasten the rubber band tightly onto the rod at the groove, making a double strand.

When launching by catapult, suspend the rubber band on the hook, holding the fuselage securely with tip of your fingers as shown in the figure. If you use more than just your fingertips, you may sometimes damage the horizontal stabilizer when the plane is launched. Pull the plane back, being careful not to bend the fuselage. You may pull back as far as you can but if you use a stronger rubber band than the one included in the kit, too much tension on the band will cause flutter. On a real plane, flutter is occurring when your paper plane makes a vibrating sound. To avoid this problem, try not to put as much tension on the rubber band.

When using a catapult, as when hand launching your plane, incline your plane 60°–90° from the horizontal to avoid loops. Bending the elevators downward slightly also serves to discourage loops.

☆ Launch your plane in a wide open area.
☆ Since the catapult-launched plane will fly at a high speed, take precautions to avoid hitting people in the area.

When considering the proper inclination that your plane should have when catapulting it, you must remember if you have a plane that tends to curve to the right, the more you incline it with the right wing downward (as in Figure A), the more the plane will tend to plunge down to the ground. If you try reversing this inclination and incline the left wing downward (as in Figure B), you will obtain better flight results.

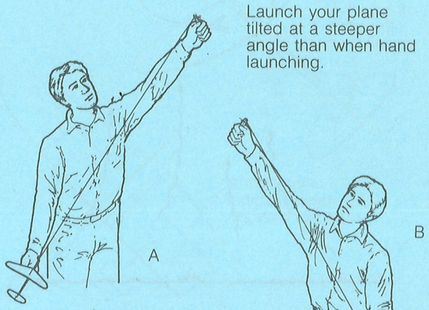
All the models in this Heritage Series, except for the Voyager, can be launched by a double strand rubber band catapult. Flutter will not be a problem if all parts are securely glued. Only the Voyager should be gently launched by a single strand rubber band catapult.

When you want your plane to spiral upwards in the way mentioned on page 15, by hand or catapult, launch it tilted away from you at a 70°–80°+ upward angle.

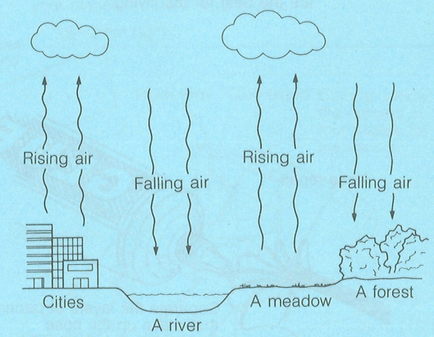
HOW TO CATCH RISING AIR CURRENTS

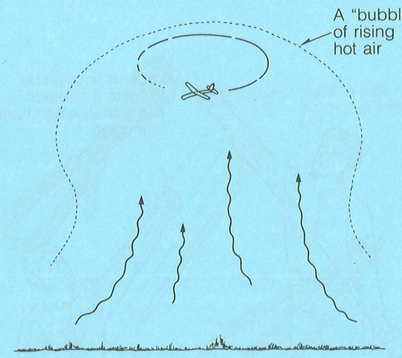
In order for a paper plane to stay aloft for over 30 seconds, it must make use of rising air currents. Rising air currents can be of two kinds; those resulting from the flow of wind over an inclined surface, and "thermals", which are rising columns of warm air. Paper planes fly well in thermals. "Thermals" originate when the earth's surface is heated by the sun. They usually originate over city streets, deserts, and plains with short grass. Lakes, rivers, and forests, however, are difficult to heat up, so these areas favor the formation of downdrafts, or descending air currents. You will be most able to make use of these "thermals" if you fly your plane over wide open grassy areas or concrete lots.

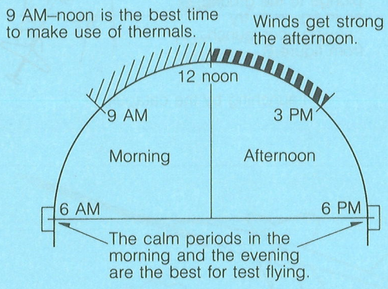
To enable your plane to make best use of these thermals, it's best to adjust it to fly in a circular pattern, then launch or throw it as high as you possibly can. Although invisible to the naked eye, there are what can be called "bubbles" of rising air, like that shown in the accompanying figure, over patches of heated ground. Therefore,

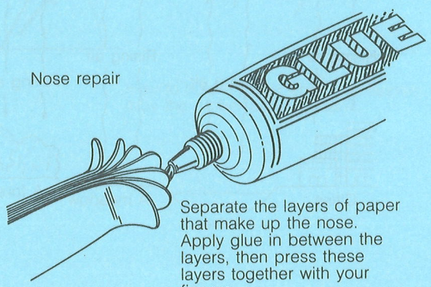

Launch your plane tilted at a steeper angle than when hand launching.
A
B
If your plane tends to plunge to the ground as in figure A, try copying your launch from figure B.

Launching by the catapult






9 AM–noon is the best time to make use of thermals.
Winds get strong in the afternoon.
12 noon
9 AM
3 PM
Morning
Afternoon
6 AM
6 PM
The calm periods in the morning and the evening are the best for test flying.


Nose repair
GLUE
Separate the layers of paper that make up the nose. Apply glue in between the layers, then press these layers together with your fingers.

if you throw your plane as stated above and get it to go around in circles and the plane enters one of these "bubbles", its chances for remaining inside this "bubble" for a considerable length of time are increased.

All the racer models included in the kit are designed to fly over one minute in rising air currents if adjusted carefully.

The best time to make use of thermals is between 9 AM and 12 noon on days when the skies are clear and the winds are gentle. Although the strength of thermals increases during midday (9 AM–4 PM) when the sun is shining most strongly and the highest temperatures are reached, in the afternoon, when thermals are strongest, gusty surface winds also get stronger, often making it difficult to fly paper planes.

Actual atmospheric conditions will not always occur at the above-mentioned times however, so always keep an eye out for chances to fly your plane.

REPAIRS

Even if your plane becomes damaged, if you repair it, you should be able to fly it again and again.

When paper planes dive to the ground or crash into a wall, the nose is especially vulnerable to damage. If any dirt or pebbles are imbedded in the nose, remove them with a pair of tweezers or a knife. Separate the various layers of paper as shown in the figure and coat all the inner surfaces with glue. Then press the layers together from the outside and, pressing hard, squeeze out all the excess glue, just as you did during assembly. Let the glue dry thoroughly.
If the wings or fuselage are bent or torn, reinforce the damaged parts from the outside by gluing on small pieces of paper, as shown in the figure. These small pieces of paper should preferably be pieces of scrap paper left over from building your plane. These pieces of paper are bend-resistant in the direction of the wing tips so be sure to cut out and apply them in the proper direction. (Bend-resistant direction of the paper is indicated by an arrow in the lower right hand corner of each model sheet.)

STORAGE

If your paper planes are well made, you should be able to preserve them with minimum care, thus enabling you to fly them for many years. For storing a large number of planes when not in use, you should stretch a piece of wire between two hooks and fasten the planes by their noses with clothespins. Let them hang vertically as shown in the figure. This has the advantage of taking up only a small amount of space, and also of minimizing the accumulation of dust on the wings.

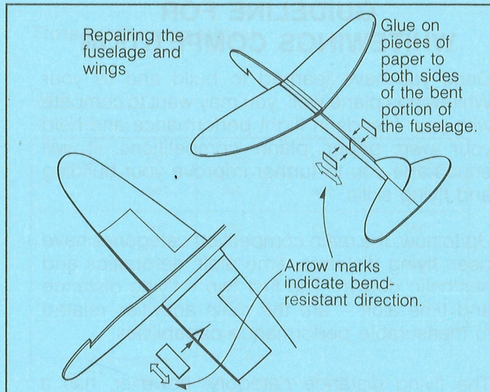
ENJOY DISPLAYING YOUR AIRPLANES

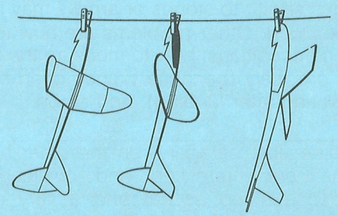
You can enjoy airplanes not only by flying them, but also, for example, by viewing them on a stand on your desk. The sleek lines of the plane's body will set your imagination off. A paper stand, that can be made very easily, is quite useful as a support for displaying an airplane.

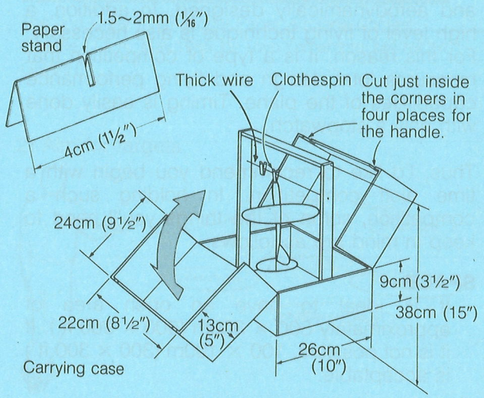
1) Prepare 4cm (1½″) square piece of paper.
2) Fold it in half.
3) Make an incision with a width of approximately 1.5–2mm (1/16″) at the center of the piece of paper.
4) Insert the fuselage between the cut.

TRANSPORTING YOUR PLANE SAFELY

In order to transport your paper planes safely from your home to an open area, I recommend using a carrying case. You may make it yourself from a carton or a light wooden box.
The carrying case should be large enough to accomodate each plane in its own space without overlapping with the others and so the planes are ready to fly with only a little adjustment. Here is one example of a carrying case I have made.


Repairing the fuselage and wings
Glue on pieces of paper to both sides of the bent portion of the fuselage.
Arrow marks indicate bend-resistant direction.
To patch a torn wing apply a small piece of paper.


Stretch a wire across an open space and hang your planes on it with clothespins.



GUIDELINE FOR WHITEWINGS COMPETITION

GUIDELINE FOR WHITEWINGS COMPETITION

Once you have learned to build and fly your Whitewings plane well, you may want to compete with your friends in flight performance and hold your own paper plane competitions. It will encourage you to further improve your building and flying skills.

Up to now, the main competition categories have been flying distance, time aloft, aerobatics and aesthetic design. The first two – flying distance and time aloft – are the main activities related to measurable performance capabilities.

The flying distance category, however, has a number of problems. Certain designs should not be included in competition. For example, designs similar to stones or arrows may need to be excluded. Other problems are how to factor for wind conditions, how to measure the landing point precisely (because planes often slide on the ground after landing), and so on.

The time aloft category, on the other hand, is much more interesting and challenging. It requires a steep ascent and a very gradual gliding descent. To attain this, the plane needs to be not only structurally sound but also light and aerodynamically designed. In addition, a high level of flying technique is also necessary. For this reason, it is a type of competition that measures total design and flying performance capabilities of the plane. Timing is easily done with only a stopwatch.

Thus, I'd like to recommend you begin with a time aloft competition. In holding such a competition, some of the things you'll need to keep in mind are as follows:

SPACE –

It is ideal to have an open area of approximately 300 × 300m (900 × 900 ft.). If it is not possible, 100 × 100m (300 × 300 ft.) is acceptable.

WEATHER –

No wind or just a breeze is best for flying paper planes. It is better to hold a competition in the morning since there is usually less wind. In a strong wind paper planes will drift or go out of control due to wind turbulence.

COMPETITION –

- **Launching:**
  You may have competitions by hand launch, by catapult launch, or both. When there is limited space or if you are indoors, you should compete only by hand launch.
- **Timing:**
  Each competitor should be timed 3 to 10 times during the competition. Even if there are many competitors, try to time each one at least 3 times.

  Clock the period consisting of when the plane leaves the hand and when it lands. If the plane is stopped by a wall or tree, stop timing the flight.

  A flight of less than three seconds should not be counted because it might be a mislaunching. If the person fails a three second flight by the third attempt, then you should count it.

  One entrant may be allowed to use more than 2 models.

  If a plane disappears from sight after circling up into the sky, or is hidden behind something, stop timing the flight.
- **Recording:**
  You may decide the winners using all the recorded times or by using the best five of ten recorded times.

  To have a constant flight performance competition, even flights of over 60 seconds should be recorded at a maximum of 60 seconds. This method eliminates a competitor who has one very lucky long flight and rewards consistent, medium length flight.

	Actual flight time	Recorded time
Entrant #1	82 sec.	60 sec.
	30	30
	26	26
	138	116
Entrant #2	47 sec.	47 sec.
	34	34
	45	45
	126	126

☆ This entrant has consistently longer flights.

Outstanding records, however, should also be awarded in some way.

The above-mentioned methods of competition are only guidelines. You can make modifications as required according to the space available, number of competitors, and the number of staff members available to oversee the competition.

If there are so many competitors that it becomes impractical to clock each several times, 10 to 20 persons could fly their planes at the same time as an eliminatory competition and the 5 people with the best times could compete with each other using the method mentioned earlier.

Time aloft competition

Date

Location

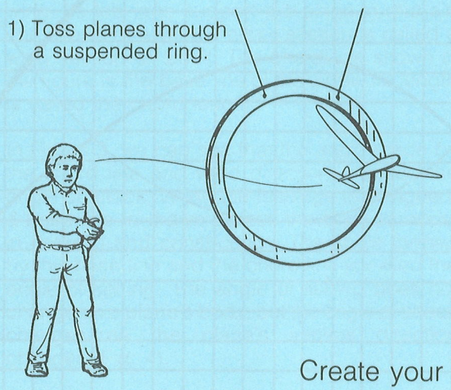
Entrant's name	1st	2nd	10th	Total of best five
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	

An example of record sheet

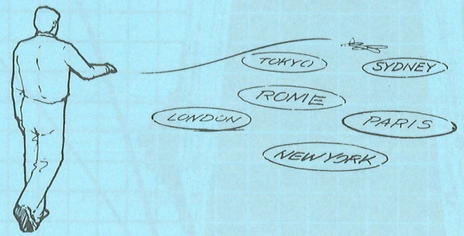
The 2nd Great International Paper Airplane Contest (Seattle, U.S.A., May 1985, by Toyo Yamamoto, *MAINICHI-GRAPH*)

You can also enjoy playing games using Whitewings planes:

1) Toss planes through a suspended ring.



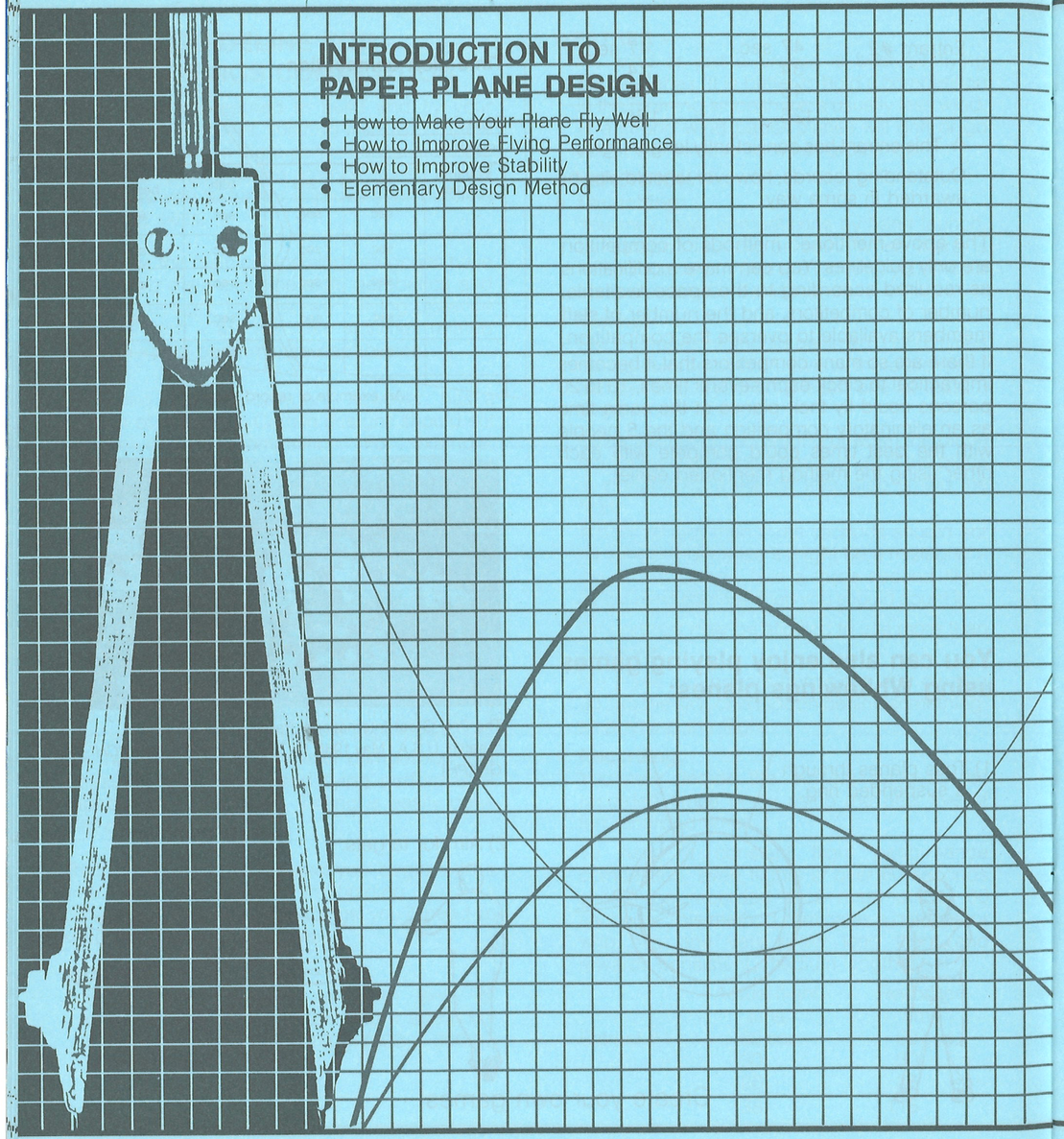
2) Aim for targets.



Create your own games!

INTRODUCTION TO PAPER PLANE DESIGN

- How to Make Your Plane Fly Well
- How to Improve Flying Performance
- How to Improve Stability
- Elementary Design Method



HOW TO MAKE YOUR PLANE FLY WELL

To make a paper plane fly its best, two conditions are very important.

1) Since a paper plane is a glider it must have good gliding performance. This will be explained more later, but basically, this means that the glide ratio is high and the rate of descent is low.
2) The plane must have good stability. This means that it must be able to correct itself and maintain a good flight after tilting or turning.

If your plane has these two qualities, when you throw it high into the air it will glide smoothly for a long distance even when there is slight air turbulence.

HOW TO IMPROVE FLYING PERFORMANCE

Figure 1 shows an airplane's parts and what they are called.

The most important part of a glider is the main wing. Its job is to support the plane in mid-air. The shape of a wing's cross section is called a wing section or airfoil. The chord line shown in the figure is the base line of the airfoil. Its length is called the chord length.

In Figure 3, we can see that the angle made by the chord line and wind direction is called the angle of attack. When the fuselage is designed, a base line is drawn across the body to assist in drawing and construction. The angle formed by this base line and the chord line is called the angle of setting. The angle of setting does not change on a plane's body, but the angle of attack changes as the plane's vertical direction changes (Fig. 4).

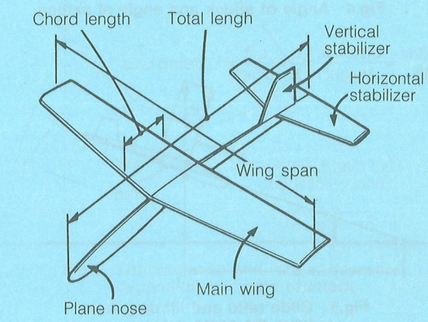


Fig.1 Plane parts and special terms

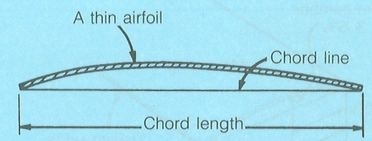


Fig.2 Cross section of a thin airfoil

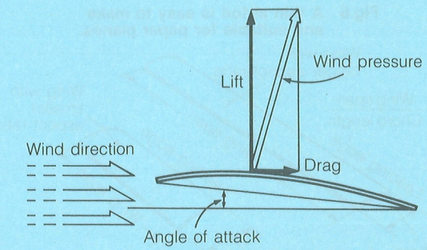


Fig.3 Angle of attack and forces on wing

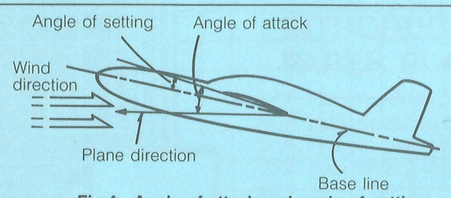


Fig.4 Angle of attack and angle of setting

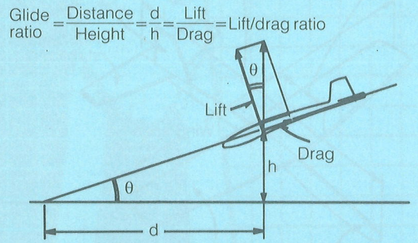


Fig.5 Glide ratio and lift/drag ratio have the same value.

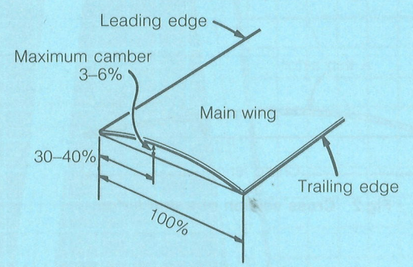


Fig.6 A thin airfoil is easy to make and suitable for paper planes.

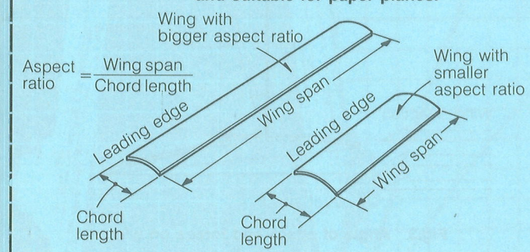


Fig.7 Aspect ratio

When the plane is gliding, wind pressure creates two forces on the wing as shown in Figure 3. One force is the upward draft of air (called lift) and the other force on the wing is called air resistance or drag. The ratio of these forces is called the lift/drag ratio. The higher the ratio of the wing (strong lift and little drag) the better the plane will fly.

As shown in Figure 5, the ratio between the distance a plane will glide and its altitude is called the glide ratio. A plane with a high glide ratio will fly farther than a plane with a lower glide ratio. The glide ratio has the same value as the lift/drag ratio of the entire plane so for long flights the lift/drag ratio must be as high as possible.

In order to have a high lift/drag ratio you must choose a good wing shape. A wing that is easy to make with a high lift/drag ratio is shown in Figure 6. As described in the chapter "Assembly Instructions", this thin type of wing is easily made by cambering the wing carefully with your fingers.

It is very important to decrease the air-drag by slimming the fuselage or by omitting parts which jut out such as the landing gear, struts, etc. as much as possible. A special ratio used to decrease drag on the wing is called the aspect ratio.

The aspect ratio is found by dividing the wing span by the chord length. The greater the aspect ratio the more slender the wing will be. As the aspect ratio of the main wing becomes larger, the less the drag on it. Real gliders and planes designed for long distance flights have long slender wings for less drag and greater lift. On a paper plane, however, which has a small body and flies at low speeds, there is no need to make the wing too slender. Rather it is best to build a light and sturdy main wing with an aspect ratio of about 5 or 6.

The lift/drag ratio changes with the glider's angle of attack. Figure 8 shows the changes. Line (A) shows the lift/drag ratio for the main wing. A 3° or 4° angle of attack is most desirable. Line (B) shows the lift/drag ratio of the whole glider. Since there is more drag on the entire glider, a 5° or 6° angle of attack is best.

When a plane is gliding and slowly losing altitude, this is called the rate of descent. It is measured in meters per second. For a long duration flight you must decrease the rate of descent. In Figure 8, line (C) shows the rate of descent. When the angle of attack is a little larger, (i.e. 1°–2° greater than that for the best lift/drag ratio), the rate of descent is the smallest.

The weight of the whole plane, divided by the surface area of the main wing, is called the wing loading. A heavy plane with small wings will have a large wing load. The Lockheed F-104 is an example of this principle. Planes with high wing loads glide faster and so their rate of descent is high.

On an actual light plane or glider the surface area of the main wing is relatively large, and because the plane is light, the wing loading is small. Due to these factors, the rate of descent is low. Accordingly they can glide, cruising for long periods of time.

When designing paper planes for long duration flights, it is best to have a low wing load by making a large wing area with a body as light as possible so your plane will fly for a long time.

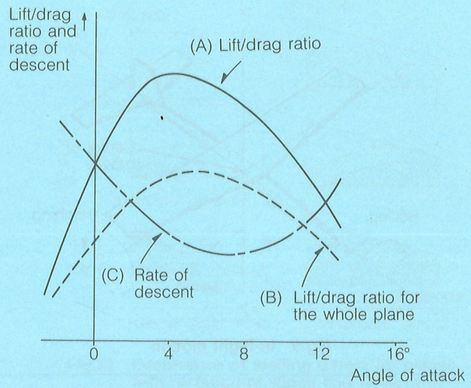


Fig.8 Lift/drag ratio and rate of descent depending on angle of attack

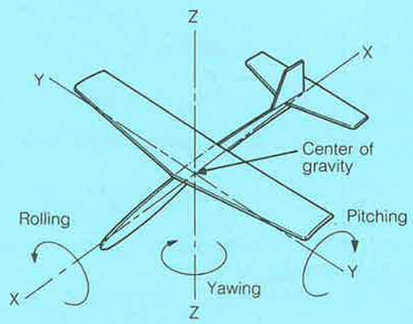


Fig.9 In-flight motion

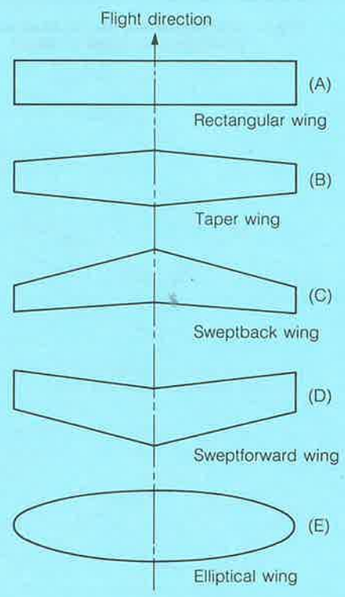


Fig.10 Wing shapes

HOW TO IMPROVE STABILITY

For a plane to fly well, it must be stable. Figure 9 shows the movements of a plane in flight. The parts which control stability are:

- HORIZONTAL STABILIZER
  – controls pitching
- VERTICAL STABILIZER
  – controls yawing
- DIHEDRAL ANGLE ON MAIN WING
  – controls rolling

For a stable plane all of these must be designed and attached properly as described in the next chapter.

ELEMENTARY DESIGN METHOD

1. Designing the Main Wing

The plane's gliding speed and rate of descent depends a lot upon the wing loading. You must decide on the wing area that is best for the plane you are building.

- When you design a plane for a long, slow, buoyant flight, give it a large wing area.
- When you design a high-speed, sleek jet plane, make the wing area small.

However, be careful not to make the wing loading too small. Although it will decrease the rate of descent, the plane won't go up very high when thrown into the air, resulting in a short flight. A wing span of less than 30cm (12″) is recommended considering the strength of the paper.

2. Main Wing Surface Shape

You can choose the wing shape you like best from the shapes in Figure 10. If the wing is either too narrow (high aspect ratio) or too wide (low aspect ratio) the plane will not be stable nor fly well. For a good flying airplane, try to avoid odd shaped wings.

The sweptback wing tends to cause "tip stall" which sends the plane into a spin, so it is best to avoid a wing with a large sweptback angle.

Figure 11 shows the relationship between the angle of attack and stalling on the rectangular wing and the sweptback wing. On the rectangular wing, air turbulence affects the central part of the wing, while on the sweptback wing, turbulence affects the wing tip which sends the plane into "tip stall." When tip stalling, the plane suddenly loses its lift.

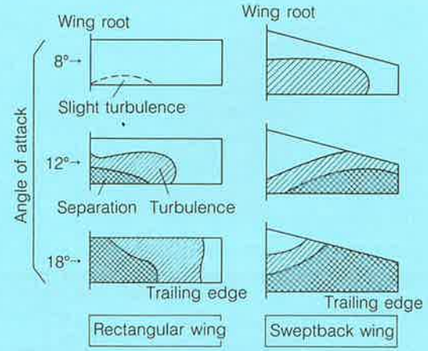


Fig.11 Occurrence of stalling differs for planes with rectangular wings and those with sweptback wings.

(From "Report and Memorandum No. 1976 of the Royal Aircraft Establishment")

Differences in the effect of air turbulence and bends or warps in the wings cause differences in wing lift. This will result in stalling (Fig. 12). The sweptback wing plane will go into a "spin" when it stalls. And so although the sweptback wing looks quite good its design does present some problems.

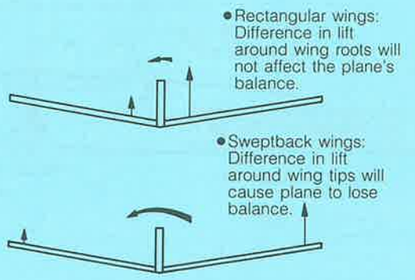

• Rectangular wings: Difference in lift around wing roots will not affect the plane's balance.
• Sweptback wings: Difference in lift around wing tips will cause plane to lose balance.

Fig.12 Difference in stall on rectangular wings and sweptback wings

3. Center of Gravity and Wing Angle of Setting

The angle of attack must be determined according to the type of glider you choose, whether it is for a long duration flight or a long distance flight. The placement of the center of gravity and the angle of setting for the main wing and horizontal stabilizer for these two types of gliders are shown in Figures 13 and 14. When the wings are positioned in this way, the angle of attack of the plane will be near to that previously explained (See Fig. 8).

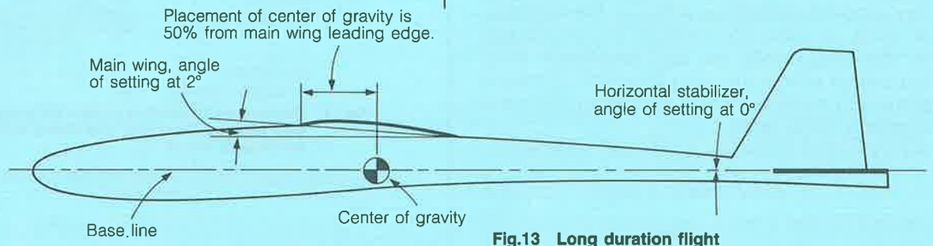


Fig.13 Long duration flight

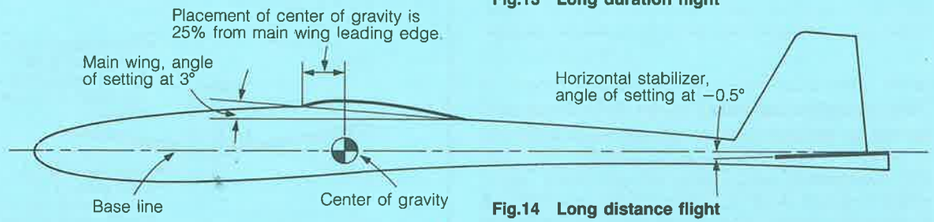


Fig.14 Long distance flight

A plane which has the center of gravity further back will be especially well balanced against pitching both at high speeds when launched and during slow gliding. Therefore the plane design having the center of gravity set back is suitable for a wide speed range.

When the wings and the center of gravity are placed according to the guidelines, then the fuselage can be designed according to what glider type you choose. The horizontal stabilizer setting might have to be adjusted to get good balance but this can be done after the test flight.

4. Center of Gravity on Non-Rectangular Wing Planes

In Figures 13 and 14, the center of gravity of the airplane is placed at a point 25% or 50% of the chord length from the main wing's leading edge. For the rectangular wing (Fig. 10-A) the chord length is the same for every part of the wing so it is easy to find the center of gravity. In the other wing shapes, the chord length changes at different places on the wing. The center of gravity on these wings depends upon the average chord length which represents the aerodynamic characteristics of the wing. This chord length is called the Mean Aerodynamic Chord (MAC) and it is easy to find. The shaded parts in Figure 15 are half the main wing (from center to wing tip).

Make a sketch of the wing in which Tt is the chord length at the wing tip and Tr is the chord length at the wing root. Extend line Tt the distance of line Tr and extend line Tr the distance of line Tt. Connect the two points (T & R) at the end with a dotted line. Find ½Tr and ½Tt and divide the wing with another dotted line. These two lines form point M. Draw a line parallel to the plane's body through M. This line will be the Mean Aerodynamic Chord length of the wing. The center of gravity should be placed at a point 25% or 50% of the MAC as seen in Figure 16.

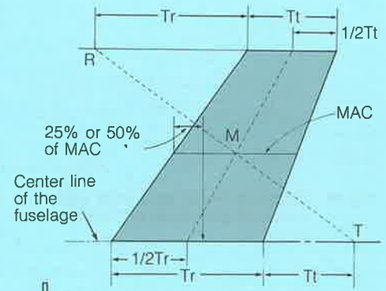


Fig.15 How to find Mean Aerodynamic Chord (MAC)

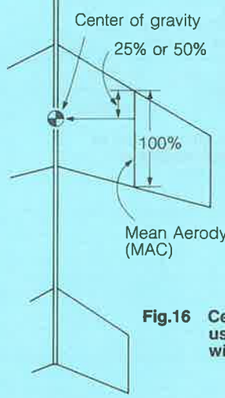


Fig.16 Center of gravity is decided using MAC formula for any wing shape not rectangular.

5. The Dihedral Angle

The reason a plane can recover from temporarily rolling to either side while in flight is because of the dihedral angle placed on the main wing.

As shown in Figure 17 the dihedral angle should be 5°—15° on a highwing glider and 15°—25° on a low wing glider.

The sweptback wing of the jet plane serves the same function as a dihedral angle. On jet planes with sweptback wings, a smaller dihedral angle than the values listed in Figure 17 is used.

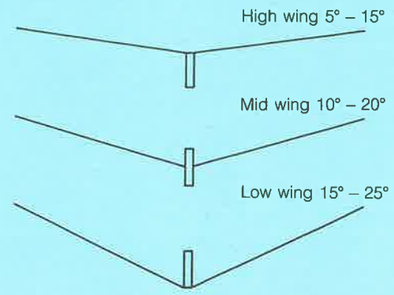


Fig.17 Wing position and suitable dihedral angle

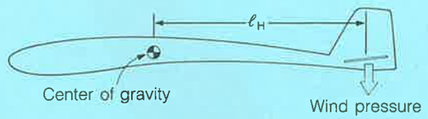


Fig.18 Stabilizer works as a lever with center of gravity as a fulcrum.

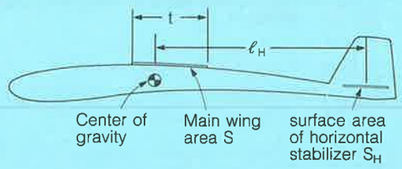


Fig.19 How to find surface area of the horizontal stabilizer

6. The Horizontal Stabilizer

The horizontal and vertical stabilizers act independently as levers supporting the center of gravity. The distance (ℓ) between the center of gravity and the horizontal and vertical stabilizers is very important. By multiplying the size of the stabilizers by this distance (ℓ) we can find how well the stabilizers work. This product is called the tail volume.

To find the best surface area for the horizontal stabilizer (S_H) the following formula is used.

- **Long duration flight**

$$S_H = 1.2\frac{S \times t}{\ell_H}$$

- **Long distance flight**

$$S_H = 0.6\frac{S \times t}{\ell_H}$$

S = Main wing surface area (cm^2)
t = Chord length (cm)
or MAC for any wing shape not rectangular.
ℓ_H = Distance from center of gravity to horizontal stabilizer (cm)

The surface area of S_H as determined by the above formula is bigger in Figure 13 than in Figure 14. This is because the further back the center of gravity, the more unstable the plane will be. Therefore, a large surface area on the horizontal stabilizer is necessary.

7. The Vertical Stabilizer

$$S_V = 0.05\frac{S \times b}{\ell_V}$$

S = Main wing surface area (cm^2)
b = Main wing span (cm)
ℓ_V = Distance from center of gravity to vertical stabilizer (cm)

The surface area of the vertical stabilizer is found using the above formula. This figure is only an estimate of the stabilizer's size. For a more precise figure the surface area of the plane body and main wing dihedral angle must also be taken into consideration.

If the vertical stabilizer is too big, or too small, the glider will not fly well. If the stabilizer is too large, the glider will tend to go into a spiral descent. If it is too small the plane will tend to spin. To find the best size for the vertical stabilizer, make it slightly larger than the size you figured in the above formula. During test flights trim it until the back end begins to sway slightly from side to side. It's fun to practice this method, so give it a try!

As long as the size of the horizontal and vertical stabilizers is right, then you may choose whatever shape you like.

8. Test Design

Let's design a paper plane now using the aforementioned explanations. We will design a rectangular winged plane for long duration flying. If we make the main wing span 22cm, and the chord length 4cm, then the main wing surface area calculation is:

$$S = 22 \times 4 = 88cm^2$$

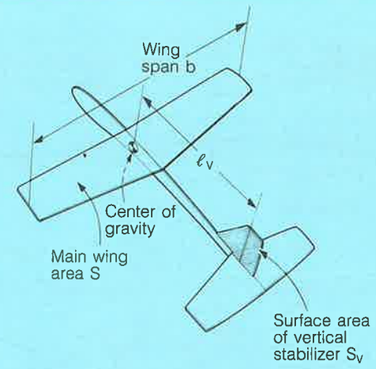
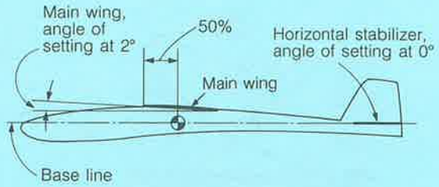


Fig.20 How to find surface area of the vertical stabilizer



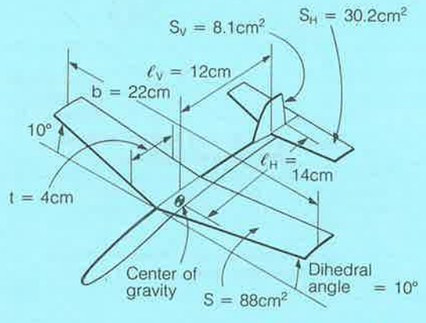


Fig.21 Test design for long duration flight

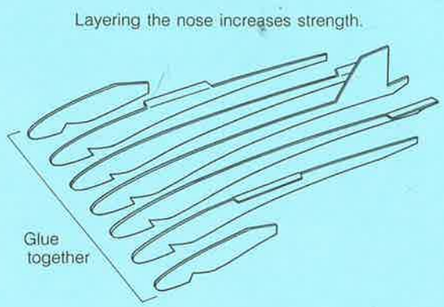


Fig.22 Composition of the fuselage

If we put the center of gravity 50% back from the main wing's leading edge (See Fig. 13) and make the distance from the center of gravity to the horizontal and vertical stabilizers respectively ℓ_H = 14cm and ℓ_V = 12cm, we can calculate S_H and S_V using the following equations (See Fig. 19 and Fig. 20).

$$S_H = 1.2\frac{88 \times 4}{14} = 30.2\text{cm}^2$$

$$S_V = 0.05\frac{88 \times 22}{12} = 8.1\text{cm}^2$$

When deciding the distance from the center of gravity to nose tip, choose a length similar to that of one of the Whitewings models. If the distance is either too long or too short, the plane will fly poorly. You can, however, design the shape as you like.

From the above values your design will be similar to the glider in Figure 21. I have made a test model of this plane and I have found that it flies very well. Enjoy designing one for yourself!

9. Plane Body Construction

When throwing the glider by hand or by catapult, the wings must be able to withstand extreme wind pressure. Also, the plane must be sturdy so it will not bend or rip when it hits the ground or walls.

For a top quality glider, some parts are designed for strength while others need to be as light as possible. The shape of the glider should be designed with the following conditions in mind. It must be easy to launch by hand, simple to repair when damaged, and it must have little wind resistance.

To meet these requirements, the actual construction of the plane body, as shown in Figure 22, is made up of layers of heavy paper. There are more layers in the nose for added strength. In Figure 23, the dashed lines show where the glider tends to bend easily. To prevent this, parts Ⓐ and Ⓑ extend past the arrow marks for reinforcement.

As shown in Figure 24, a backing is glued to the underside of the wing's center in order to keep the main wing from bending and twisting due to wind pressure. Further, to obtain better performance, the wing should be slightly cambered as in Figure 6. This type of main wing is also easy to repair.

10. Layers of Paper and Bending Strength

One of the main reasons why paper planes don't fly well is that the midsection, the part of the body between the main wing and the tail, tends to bend from side to side. When this happens, the plane spirals down sharply after it is launched. It is thus important to try to design your planes so that they don't bend in this section.

It is for this reason that Whitewings paper airplanes are designed to be 5 to 7 layers thick in the midsection of the fuselage. As you can see in Figure 25, the bending strength is proportionate to the cube of the width (w) times the height (m) :

Bending strength $\propto (w^3 \times m)$

Taking the thickness, and thus the strength, of one piece of paper as a constant, we can substitute the number of layers of paper (n) for the width (w) as follows:

Bending strength $\propto (n^3 \times m)$

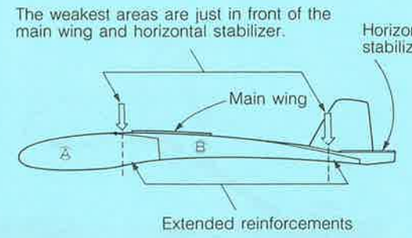


Fig.23 Reinforcement of easily bendable parts

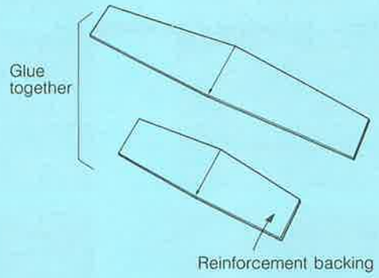


Fig.24 Composition of the main wing

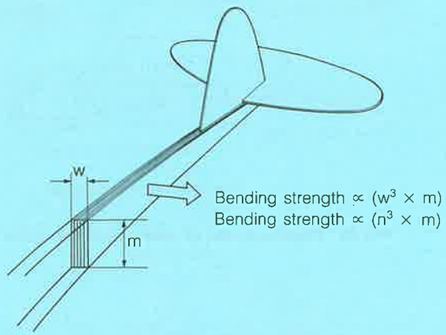


Fig.25 Dimensions of the fuselage and bending strength

If we compare the use of six layers of paper with five layers of paper, we find that six layers of paper leads to about 1.73 times the strength.

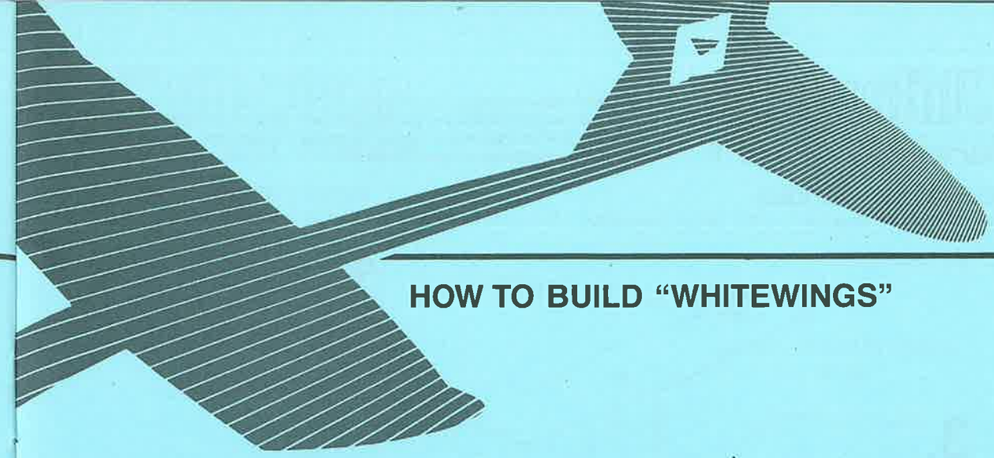
$$\frac{6 \text{ layers}}{5 \text{ layers}} = \frac{6^3 \times m}{5^3 \times m} = \frac{216}{165} \fallingdotseq 1.73$$

One other thing that becomes clear is that it is much more effective to increase the number of layers of paper than it is to increase the height of the body in order to increase strength and reduce bending. If too many layers of paper are used, however, the plane becomes too heavy. At the same time, it is important to make sure that the several layers of paper are glued together securely. If the gluing is incomplete, then the bending strength is n × m rather than n^3 × m, leading to a much reduced strength.

The racer type planes included in this Whitewings kit consist of both 5 to 7 layer designs. When you fly them you will feel a slight difference between the two. While you'll need to be much more careful about how you fly the five layer ones, you'll see that they have a lighter and spirited feeling to their flight. I hope that you'll try constructing, flying, and comparing the performance of both types to see for yourself how different they are.

This concludes my explanation of simple design methods. You can now use this knowledge to help you design your own gliders.

Good Luck and Good Flying!



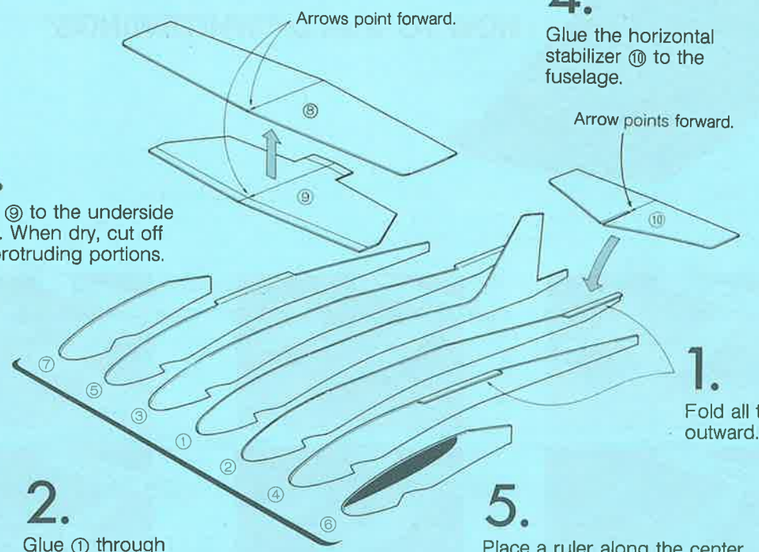
HOW TO BUILD "WHITEWINGS"

P. 36 Racer 519 "PAPPY"
P. 37 Racer 520 AMELIA
P. 39 Racer 521 JACQUELINE
P. 40 Racer 522 RICHARD
P. 42 Racer 523 "BILLY"
P. 45 TriLinear 701 LINDBERG
P. 46 TriLinear 702 RICKENBACKER
P. 47 TriLinear 703 CHENNAULT
P. 48 Light Plane 305 WILBUR
P. 50 Light Plane 306 ORVILLE
P. 52 PHANTOM II
P. 53 "STREGA"
P. 54 CONSTELLATION
P. 55 C130 HERCULES
P. 56 "VOYAGER"

Whitewings®
Racer 519 "PAPPY"

Gregory "Pappy" Boyington (1912–1988)
One of the original members of the "Flying Tigers" group in China, Boyington soon qualified as an ace. Nicknamed "Pappy" by his men, he served as the commander of the celebrated fighting unit–the "Blacksheep".

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



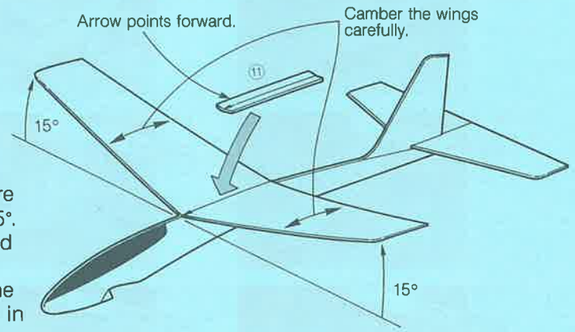
3. Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.

4. Glue the horizontal stabilizer ⑩ to the fuselage.

1. Fold all tabs outward.

2. Glue ① through ⑦ together.

5. Place a ruler along the center line of the main wing (⑧+⑨) and make a dihedral angle of approximately 15°. Then glue it firmly to the fuselage.



FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

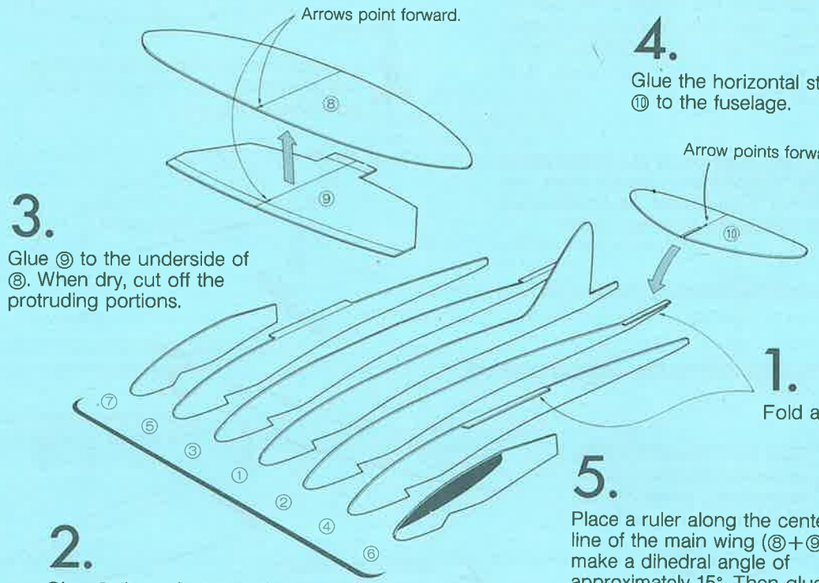
6. Camber the main wings carefully with your fingers.
7. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
8. Fold ⑪ up slightly along the center line and glue it onto the center of the main wing.
9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Whitewings®
Racer 520 AMELIA

Amelia Earhart (1898–1937)
Beginning her career as a log keeper, Amelia earned instant fame as the first woman to cross the Atlantic as a passenger. She went on to be the first woman pilot to make a solo transatlantic flight.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



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2. Glue ① through ⑦ together.

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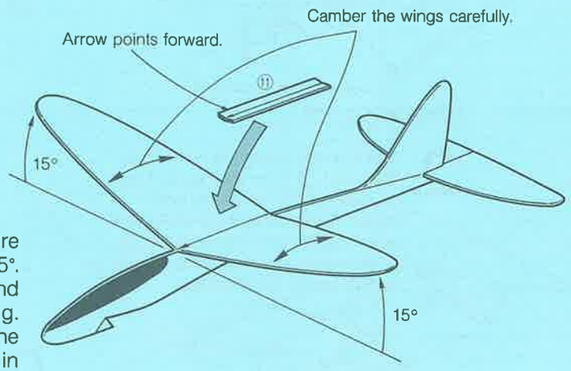

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9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Whitewings

HOW TO ASSEMBLE THE MOST WINGS

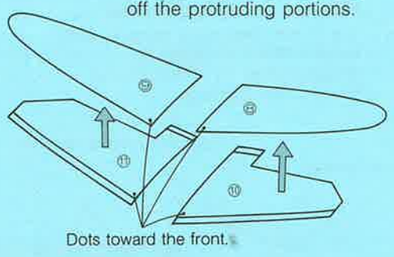
Three of the racer type planes in this Heritage Series have a high performance main wing featuring a uniform camber along the length of the wing. Because the shape of the central part of the wing resembles a so-called saddle shaped surface in math, I call this type of wing a MOST (Modified Saddle Type) wing. It is constructed as follows.

CAUTION 1
The parts numbers used below are for the Racer 521. As the part numbers and dihedral angle may change according to the model, be careful when you use these instructions for other models.

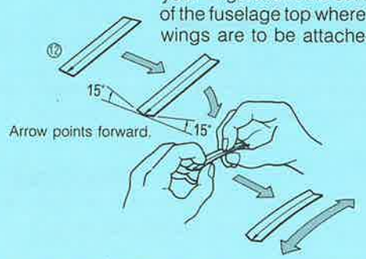
CAUTION 2
When constructing the Racer 522, start with step 0.

■ Glue parts together in the order indicated.

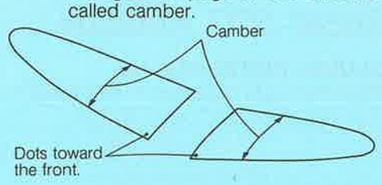
1. Glue parts ⑩ and ⑪ to the undersides of parts ⑧ and ⑨ respectively. When dry, cut off the protruding portions.



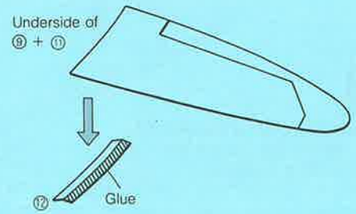
2. Using a ruler along the center line, fold part ⑫ from the center line to make a 15° angle on both sides. Then curve it carefully with your fingers to fit the curved edge of the fuselage top where the main wings are to be attached.



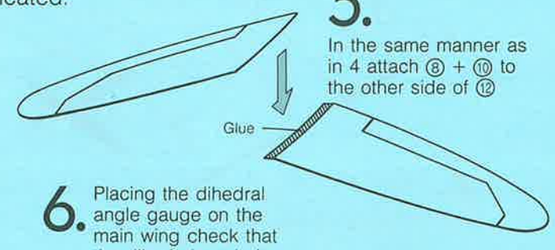
3. Curve the main wings, ⑧ + ⑩ and ⑨ + ⑪ respectively, in the manner shown in the figure on page 9. This curve is called camber.



4. Apply glue on half of the underside of ⑫ and glue onto ⑨ + ⑪ (The arrow should point toward the dot.)

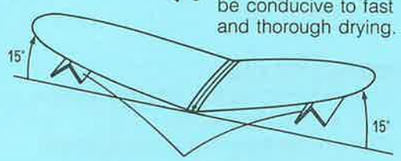


5. In the same manner as in 4 attach ⑧ + ⑩ to the other side of ⑫

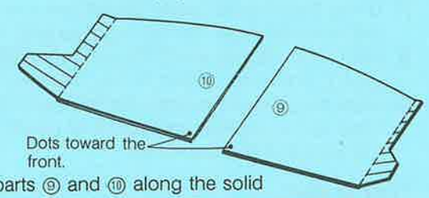


6. Placing the dihedral angle gauge on the main wing check that the dihedral angle is 15°.

7. Putting folded stands under the main wing will be conducive to fast and thorough drying.



Folded paper stands



0. Dots toward the front.
Cut parts ⑨ and ⑩ along the solid lines up to the dashed lines. Then placing a ruler along the dashed line, bend the resulting strips slightly upward.

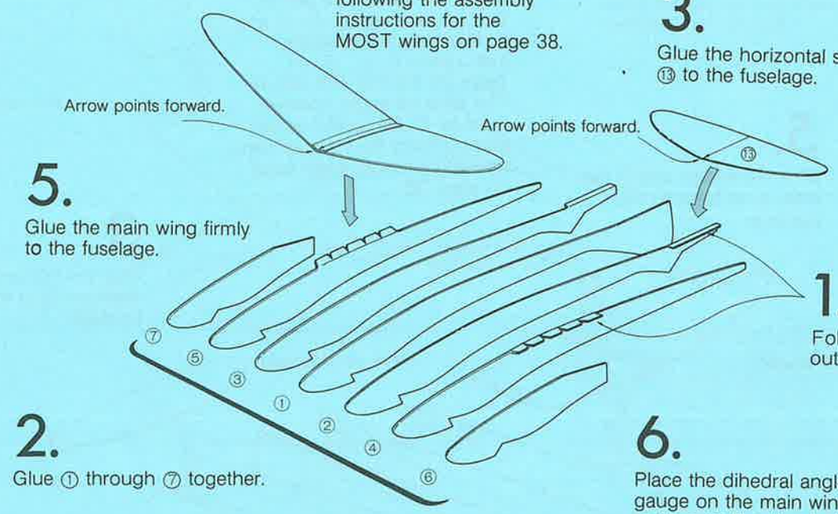
Whitewings
Racer 521 JACQUELINE

Jacqueline Cochran (1910–1980)
Soon after her first flying lessons in 1932, Jacqueline mastered the technical aspects of aviation and navigation. She was the first woman to enter the Bendix Transcontinental Air Race in 1935, and captured the Bendix Trophy in 1938.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

4. Assemble the main wing following the assembly instructions for the MOST wings on page 38.

3. Glue the horizontal stabilizer ⑬ to the fuselage.



5. Glue the main wing firmly to the fuselage.

1. Fold all tabs outward.

2. Glue ① through ⑦ together.

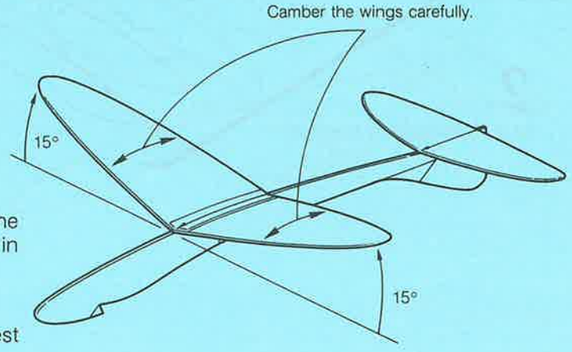
6. Place the dihedral angle gauge on the main wing to make sure the dihedral angle is 15°.

FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

7. Camber the main wings carefully with your fingers.
8. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Camber the wings carefully.



Whitewings
Racer 522 RICHARD

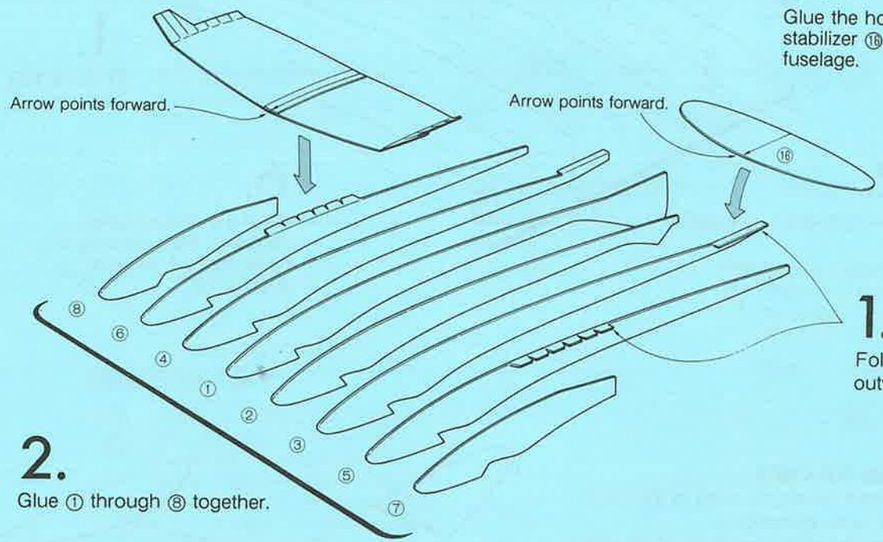
Richard Ira Bong (1920–1945)
Though his career was short-lived, Richard soon established himself as a squadron leader and an ace flyer during World War II. He was awarded the Medal of Honor for his efforts during the war and is remembered for his gallantry.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

4.
Assemble the middle part of the wing with ⑨, ⑩, ⑪, ⑫ and ⑬ following the assembly instructions 0. 1. .....7. on page 38, starting with step 0. The dihedral angle, however, must be 5°. Be careful as the part numbers for the main wing are different from those listed on page 38.

5.
Glue the middle part of the main wing firmly to the fuselage.

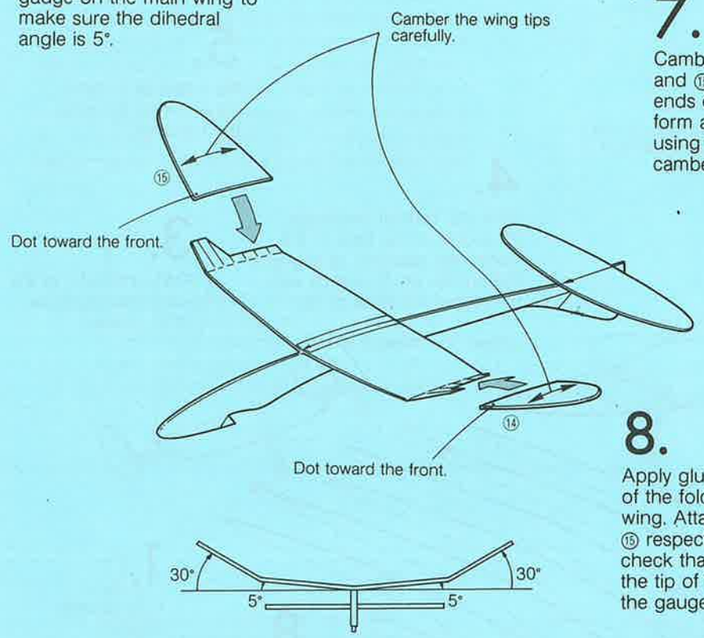
3.
Glue the horizontal stabilizer ⑯ to the fuselage.



1.
Fold all tabs outward.

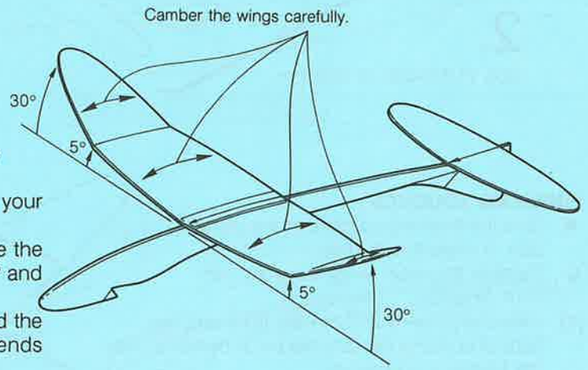
2.
Glue ① through ⑧ together.

6.
Place the dihedral angle gauge on the main wing to make sure the dihedral angle is 5°.



7.
Camber both wing tips ⑭ and ⑮. Fold tabs on both ends of the main wing to form a 30° dihedral angle using the gauge and then camber them as well.

8.
Apply glue to the top surface of the folded tabs of the main wing. Attach wing tips ⑭ and ⑮ respectively. Once again, check that the dihedral angle at the tip of the wing is 30°, using the gauge.



FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

9. Camber the main wings carefully with your fingers.
10. Using the dihedral angle gauge insure the dihedral angle for the main wing is 5° and for the wing tips 30°.
11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Whitewings
Racer 523 "BILLY"

William "Billy" Mitchell (1879–1936)
An outspoken proponent of the use of Military Air Power, "Billy" began his career as a private and advanced to the rank of brigadier general. He is known as the first American airman to fly over enemy lines.

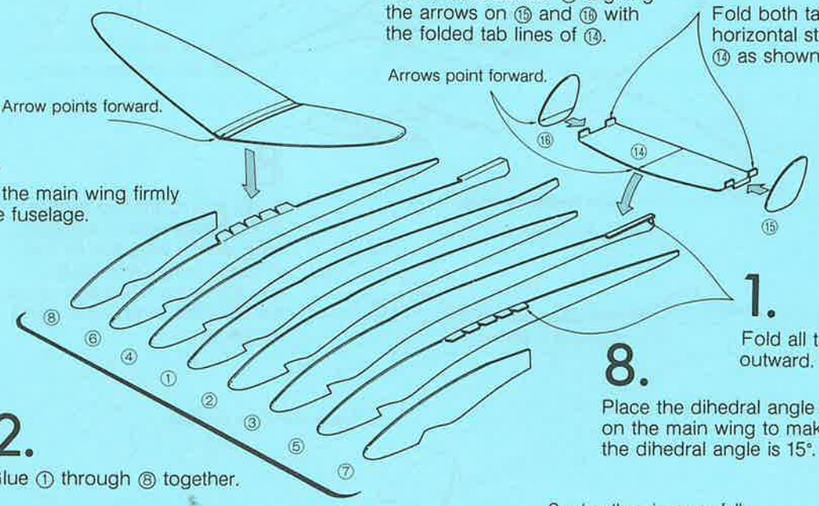
GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

6.
Assemble the main wing following the assembly instructions for the MOST wings on page 38.
Be careful as the part numbers for the main wing are different from those listed on page 38.

5.
Glue the tail section (⑭+⑮+⑯) firmly to the fuselage.

4.
Glue the vertical stabilizers ⑮ and ⑯ to the tabs of the horizontal stabilizer ⑭ aligning the arrows on ⑮ and ⑯ with the folded tab lines of ⑭.

3.
Fold both tabs of the horizontal stabilizer ⑭ as shown.

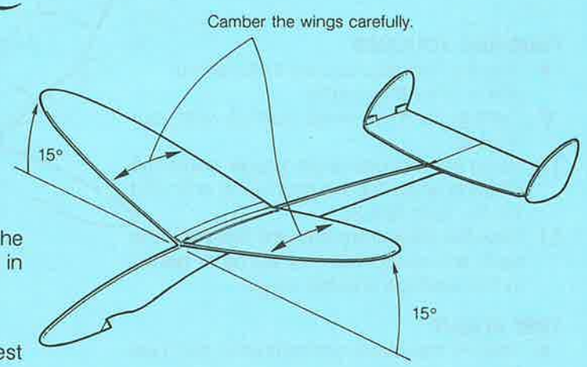


7.
Glue the main wing firmly to the fuselage.

2.
Glue ① through ⑧ together.

1.
Fold all tabs outward.

8.
Place the dihedral angle gauge on the main wing to make sure the dihedral angle is 15°.



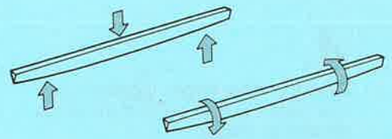
FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

9. Camber the main wings carefully with your fingers.
10. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

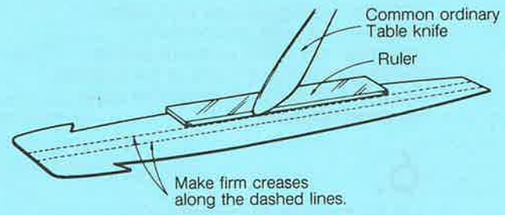
Whitewings
ASSEMBLY INSTRUCTIONS FOR THE TRIANGULAR LONG FUSELAGE

A truly high performance paper plane is light, sturdy, and has little air resistance or drag. This is especially true of larger paper airplanes. That is why I have spent some time researching and designing a fuselage that accomodates the body construction of a larger paper airplane. The result of these efforts was the invention of the triangular long fuselage which is resistant to bending and twisting. Its aerodynamic performance makes it worthy of the Whitewings' name.

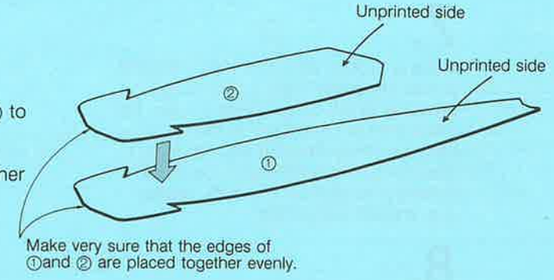


The triangular long fuselage is resistant to both bending and twisting.

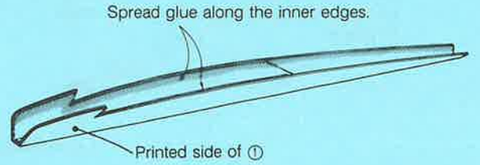
1.
Make firm creases along the dashed lines of fuselage pieces (① & ②) using a common ordinary table knife (blunt knife) and a ruler as a guide.
Avoid cutting through the dashed lines.



2.
Spread glue evenly over the entire surface of printed side of ②. Apply ② to the unprinted side of ①. Make very sure that the edges of ① and ② that form the plane nose are placed together evenly, or flush, as shown in the diagram.

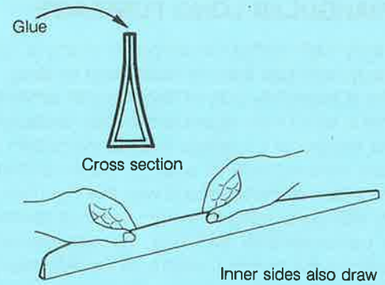


3.
Before the glue dries, fold ① and ② along the creased dashed lines having ② face inward. Then spread glue along the inner edges as shown.



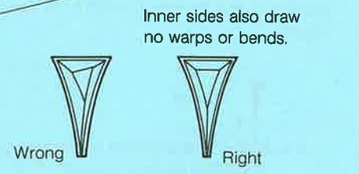
4.

Glue the inner edges together to complete the formation of the cross section as shown.



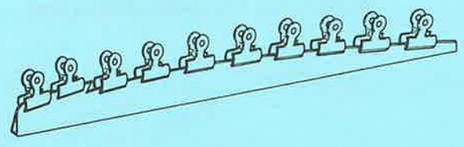
5.

View the fuselage closely from both the front and back and carefully straighten any warps or bends before the glue dries. Look inside of the fuselage to make sure the inner sides also draw no warps or bends.



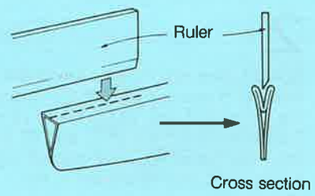
6.

Let the fuselage dry completely by attaching clips or clothespins on the glued edges as shown. It takes at least 2 hours to dry.



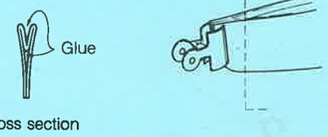
7.

Make a groove along the thick dashed line at the plane nose by carefully pressing down upon it with a ruler. The groove must be deeper at the tip of the plane nose than at any other part. The remaining area of the top of the fuselage, except for the thick dashed line, should remain flat.



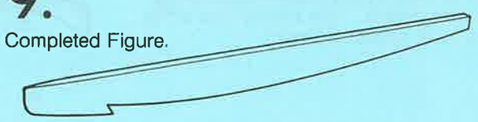
8.

Put glue into the groove at the tip of the plane nose and both inner sides of the plane nose and glue together. Let it dry thoroughly (at least 2 hours) using a clip to keep the tip of the nose in place.



9.

Completed Figure.



Whitewings®
TriLinear 701 LINDBERG

Charles Lindberg (1902–1974)
Well-known pilot of the Spirit of St. Louis, "Lucky Lindy" made the first solo nonstop transatlantic flight. He became a respected aviation consultant, won a Pulitzer Prize for his autobiography, and was awarded a Congressional Medal of Honor.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

1.

Assemble the fuselage following the assembly instructions for the triangular long fuselage on pages 43 & 44.

6.

Place a ruler along each of the outer lines of the main wing and bend each side up individually to make a dihedral angle of approximately 15° for both sides of the main wing.

4.

Glue the vertical stabilizers ⑥ and ⑦ to the tabs of the horizontal stabilizer ⑤ aligning the arrows on ⑥ and ⑦ with the folded tab lines of ⑤.

3.

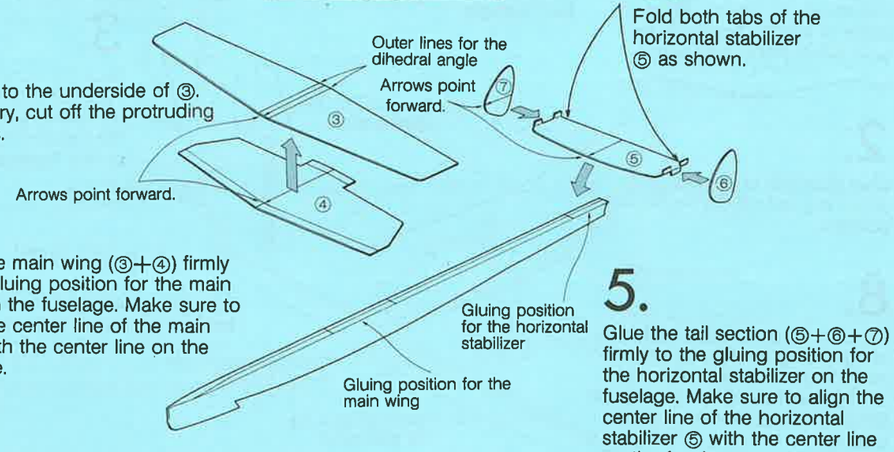
Fold both tabs of the horizontal stabilizer ⑤ as shown.

2.

Glue ④ to the underside of ③. When dry, cut off the protruding portions.

7.

Glue the main wing (③+④) firmly to the gluing position for the main wing on the fuselage. Make sure to align the center line of the main wing with the center line on the fuselage.



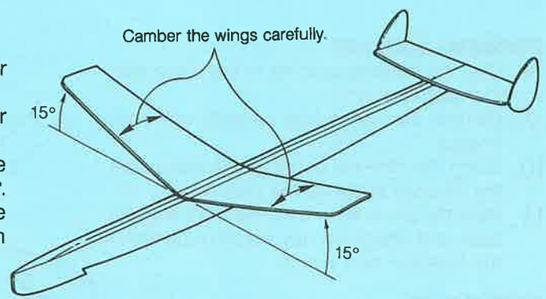
5.

Glue the tail section (⑤+⑥+⑦) firmly to the gluing position for the horizontal stabilizer on the fuselage. Make sure to align the center line of the horizontal stabilizer ⑤ with the center line on the fuselage.

FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

8. Camber the main wings carefully with your fingers.
9. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
10. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.



TEST FLIGHT

- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Whitewings
TriLinear 702 RICKENBACKER

Edward Vernon Rickenbacker (1890–1973)
Known as "Eddie", this American aviator's interest with machines began with automobile racing. He went on to command the 94th Aero Pursuit squadron and was awarded the Congressional Medal of Honor for his combat heroics.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

1.
Assemble the fuselage following the assembly instructions for the triangular long fuselage on pages 43 & 44.

7.
Place a ruler along each of the outer lines of the main wing and bend each side up individually to make a dihedral angle of approximately 15° for both sides of the main wing.

2.
Glue ④ to the underside of ③. When dry, cut off the protruding portions.

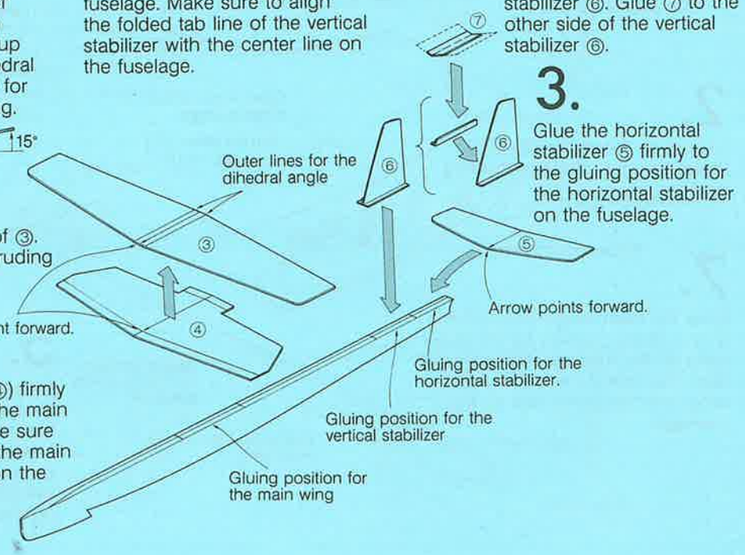
8.
Glue the main wing (③+④) firmly to the gluing position for the main wing on the fuselage. Make sure to align the center line of the main wing with the center line on the fuselage.

6.
Glue the vertical stabilizer (⑥+⑦) to the gluing position for the vertical stabilizer on the fuselage. Make sure to align the folded tab line of the vertical stabilizer with the center line on the fuselage.

4.
Fold ⑦ along the dashed line at a 90° angle and then cut off the protruding portions.

5.
Fold the tab of the vertical stabilizer ⑥. Glue ⑦ to the other side of the vertical stabilizer ⑥.

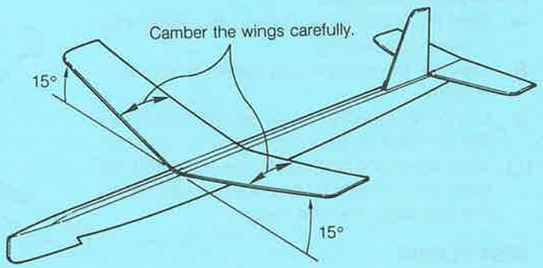
3.
Glue the horizontal stabilizer ⑤ firmly to the gluing position for the horizontal stabilizer on the fuselage.



FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

9. Camber the main wings carefully with your fingers.
10. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.



Whitewings
TriLinear 703 CHENNAULT

Claire Lee Chennault (1890–1958)
Owing to a detailed study of pursuit maneuvers and tactics, he became a specialist in wartime aviation. Because of this expertise, he was recruited by the Nationalist Chinese to train and organize their air defense forces which became known as the "Flying Tigers".

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

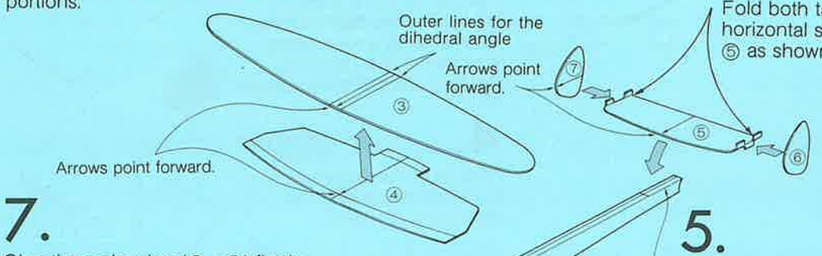
1.
Assemble the fuselage following the assembly instructions for the triangular long fuselage on pages 43 & 44.

6.
Place a ruler along each of the outer lines of the main wing and bend each side up individually to make a dihedral angle of approximately 15° for both sides of the main wing.

4.
Glue the vertical stabilizers ⑥ and ⑦ to the tabs of the horizontal stabilizer ⑤ aligning the arrows on ⑥ and ⑦ with the folded tab lines of ⑤.

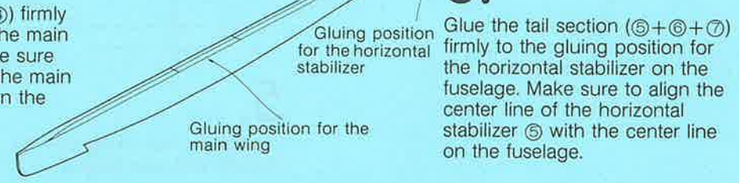
2.
Glue ④ to the underside of ③. When dry, cut off the protruding portions.

3.
Fold both tabs of the horizontal stabilizer ⑤ as shown.



7.
Glue the main wing (③+④) firmly to the gluing position for the main wing on the fuselage. Make sure to align the center line of the main wing with the center line on the fuselage.

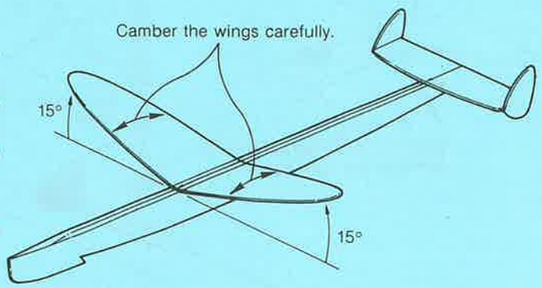
5.
Glue the tail section (⑤+⑥+⑦) firmly to the gluing position for the horizontal stabilizer on the fuselage. Make sure to align the center line of the horizontal stabilizer ⑤ with the center line on the fuselage.



FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

8. Camber the main wings carefully with your fingers.
9. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
10. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.



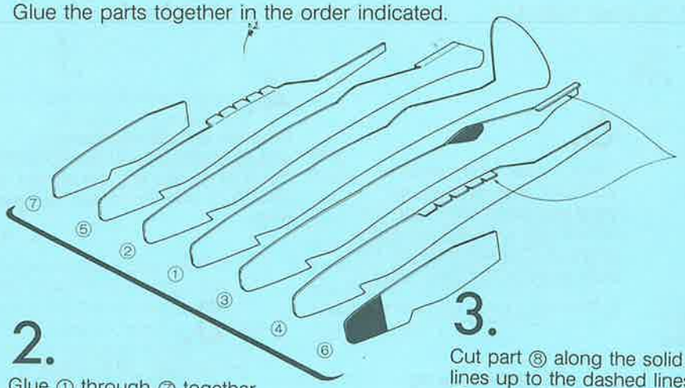
Whitewings

Light Plane 305 WILBUR

Wilbur Wright (1867—1912)
This pioneer of American aviation experimented with kites and gliders before engineering the first successful flight of a motor-powered airplane. He was posthumously elected, as was brother Orville, to the American Hall of Fame.

GLUING INSTRUCTIONS

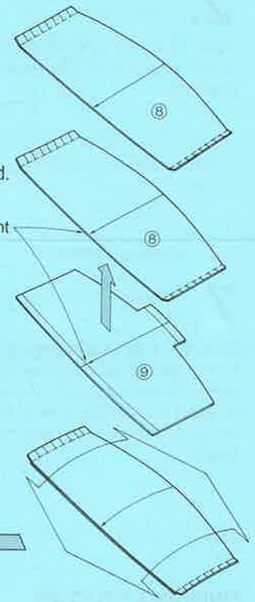
Glue the parts together in the order indicated.



1.
Fold all tabs outward.

2.
Glue ① through ⑦ together.

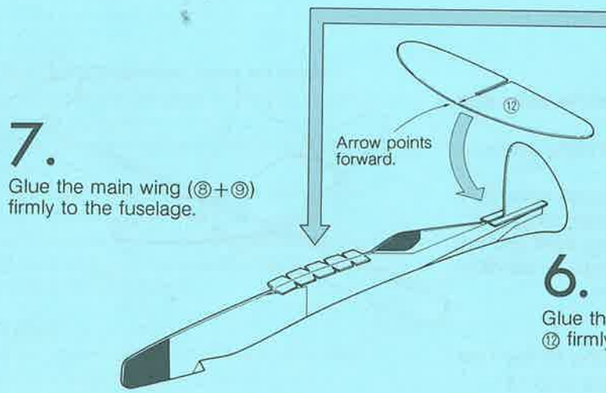
3.
Cut part ⑧ along the solid lines up to the dashed lines. Then placing a ruler along the dashed line, bend the resulting strips slightly upward.



4.
Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.

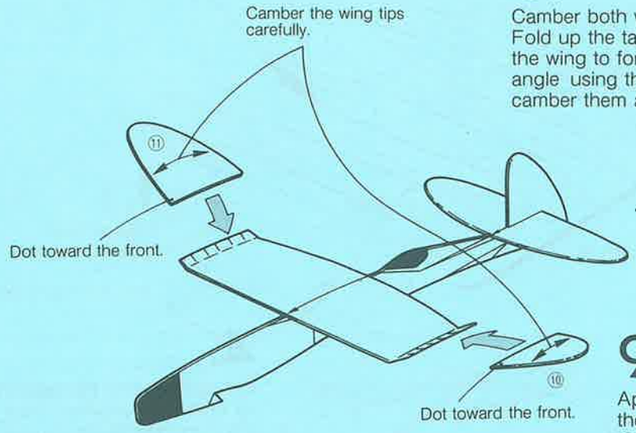
Arrows point forward.

5.
Camber the main wing (⑧+⑨) carefully with your fingers.



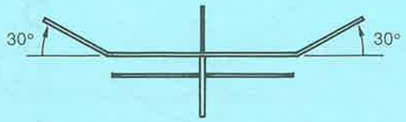
7.
Glue the main wing (⑧+⑨) firmly to the fuselage.

6.
Glue the horizontal stabilizer ⑫ firmly to the fuselage.

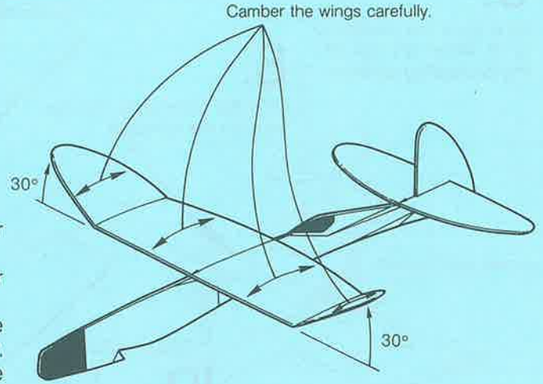


8.
Camber both wing tips ⑩ and ⑪. Fold up the tabs on both ends of the wing to form a 30° dihedral angle using the gauge and then camber them as well.

9.
Apply glue to the top surface of the folded tabs of the main wing and attach wing tips ⑩ and ⑪ respectively. Using the dihedral angle gauge, once again, check that the dihedral angle for the wing tips are 30°.



Camber the wings carefully.



FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

10. Camber the main wings carefully with your fingers.
11. Using the dihedral angle gauge make sure the dihedral angle for the wing tips are 30°.
12. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

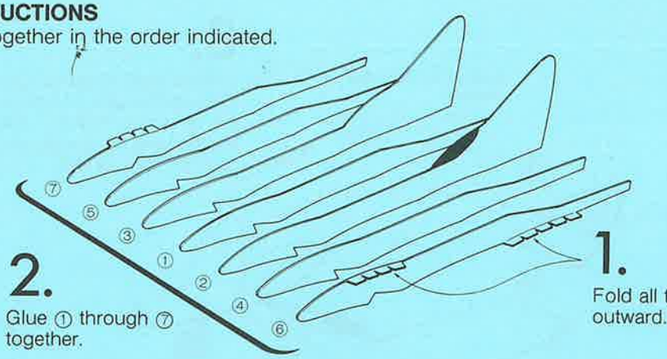
TEST FLIGHT

- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Whitewings
Light Plane 306 ORVILLE

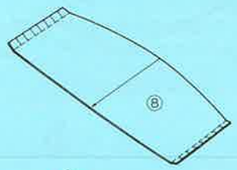
Orville Wright (1871–1948)
Considered a dreamer, the impetuous younger brother of the Wright Brothers duo, Orville became one of America's pioneers in aviation through the use of his prolific imagination and the help and encouragement of his brother.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



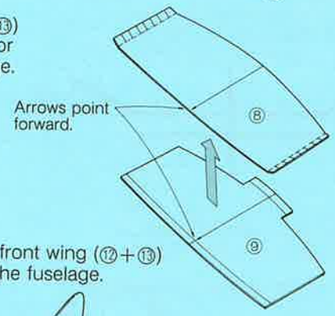
2.
Glue ① through ⑦ together.

1.
Fold all tabs outward.



4.
Cut part ⑧ along the solid lines up to the dashed lines. Then placing a ruler along the dashed line bend the resulting strips slightly upward.

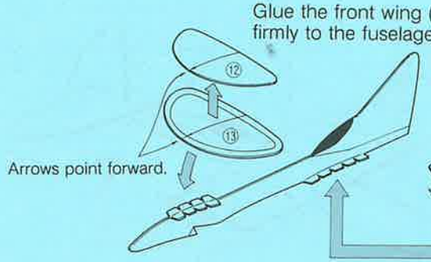
7.
Camber the front wing (⑫+⑬) in line with the curved tabs for the front wing on the fuselage.



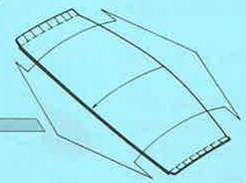
5.
Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.

3.
Glue ⑬ to the underside of ⑫. When dry, cut off the protruding portions.

8.
Glue the front wing (⑫+⑬) firmly to the fuselage.



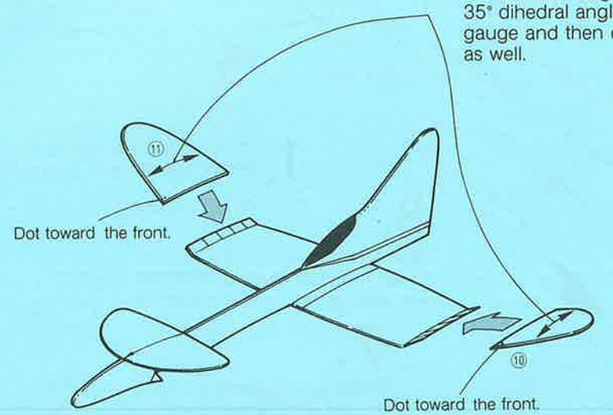
6.
Make a pinhole at both ends of the center line on the top side of the main wing. Turn the main wing over. Link the pinholes together with a ruler and draw a center line on the bottom side of the main wing.

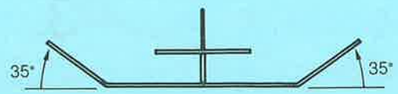


9.
Camber the main wing (⑧+⑨) carefully with your fingers.

10.
Glue the main wing (⑧+⑨) firmly to the fuselage.

11.
Camber both wing tips of ⑩ and ⑪. Fold up the tabs on both ends of the wing to form a 35° dihedral angle using the gauge and then camber them as well.





12.
Apply glue to the top surface of the folded tabs of the main wing and attach wing tips ⑩ and ⑪ respectively. Using the gauge, once again, check that the dihedral angle for the wing tips are 35°.

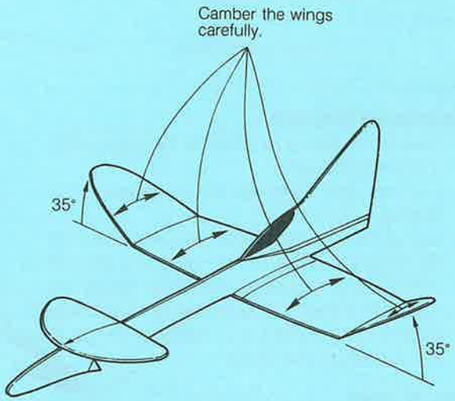
FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

13. Camber the main wings carefully with your fingers.
14. Using the dihedral angle gauge make sure the dihedral angle for the wing tips are 35°.
15. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT

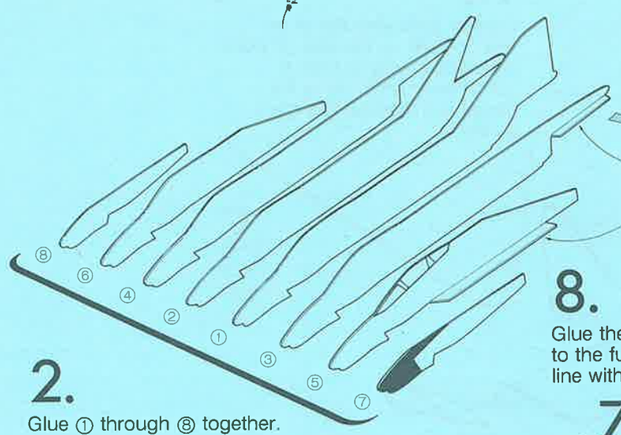
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.



Whitewings

McDonnell Douglas PHANTOM II

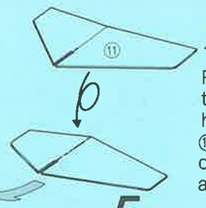
GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



2.
Glue ① through ⑧ together.

1.
Fold all tabs outward.

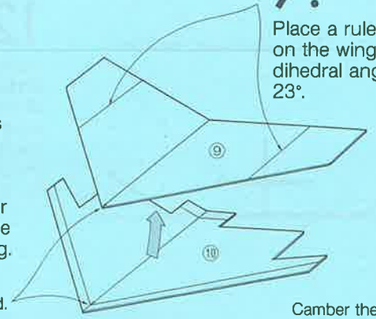
4.
Place a ruler along the center line of the horizontal stabilizer ⑪ and make a dihedral angle of approximately 12°.



5.
Turn the horizontal stabilizer ⑪ upside down and glue it firmly to the fuselage to form a dihedral angle of minus 12°.

8.
Glue the main wing (⑨+⑩) firmly to the fuselage aligning its center line with the center of the fuselage.

7.
Place a ruler along the lines on the wing tips and make a dihedral angle of approximately 23°.



6.
Make a pinhole at both ends of the center line on the top side of the main wing. Turn the main wing over. Link the pinholes together with a ruler and draw a center line on the bottom side of the main wing.

Arrows point forward.

3.
Glue ⑩ to the underside of ⑨. When dry, cut off the protruding portions.

FINISHING TOUCHES

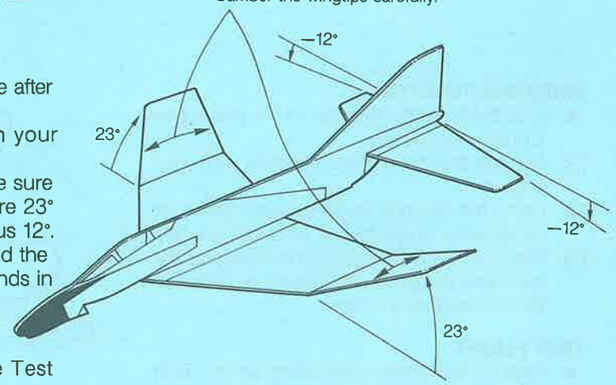
- Give the finishing touches to the plane after it dries thoroughly.

9. Camber the wingtips carefully with your fingers.
10. Using the dihedral angle gauge make sure the dihedral angle for the wing tips are 23° and for the horizontal stabilizer minus 12°.
11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT

- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Camber the wingtips carefully.

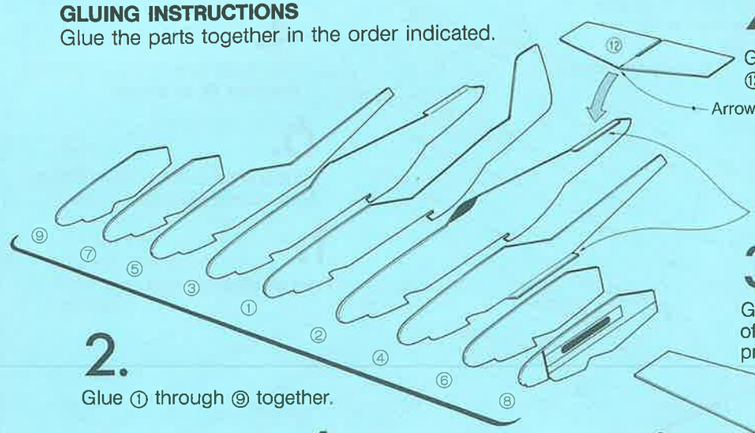


Whitewings

"STREGA" (Modified P-51 MUSTANG)

Each year, in September, the city of Reno holds a National Championship Air Race. (Reno is in the Nevada Desert about 220 miles northeast from San Francisco.) The Strega achieved a new race record with an average speed of 454 mph in the Reno Air Race in 1987. The unlimited class is comprised of many racing models, including modified battle planes with great horsepower such as the Mustang, Bearcat, Corsair, and Sea-Fury, that were at work during World War II. The Strega, meaning "witch" in Italian, is a remodeled Mustang P-51.

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



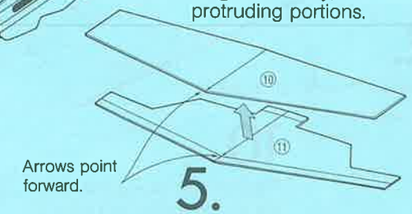
2.
Glue ① through ⑨ together.

4.
Glue the horizontal stabilizer ⑫ firmly to the fuselage.

Arrow points forward.

1.
Fold all tabs outward.

3.
Glue ⑪ to the underside of ⑩. When dry, cut off the protruding portions.



Arrows point forward.

6.
Place a ruler along the center line of the main wing (⑩+⑪) and make a dihedral angle of approximately 12°. Then glue it firmly to the fuselage.

5.
Make a pinhole at both ends of the center line on the top side of the main wing. Turn the main wing over. Link the pinholes together with a ruler and draw a center line on the bottom side of the main wing.

FINISHING TOUCHES

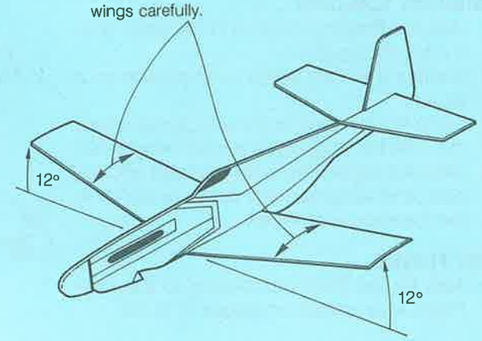
- Give the finishing touches to the plane after it dries thoroughly.

7. Camber the main wings carefully with your fingers.
8. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 12°.
9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

TEST FLIGHT

- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Camber the wings carefully.

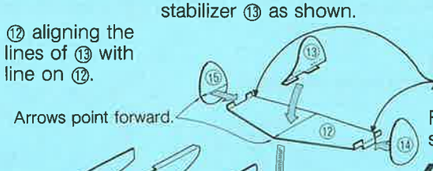


Whitewings
Lockheed CONSTELLATION

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

8.
Glue ⑬ to ⑫ aligning the folded tab lines of ⑬ with the center line on ⑫.

7.
Fold tabs of the vertical stabilizer ⑬ as shown.

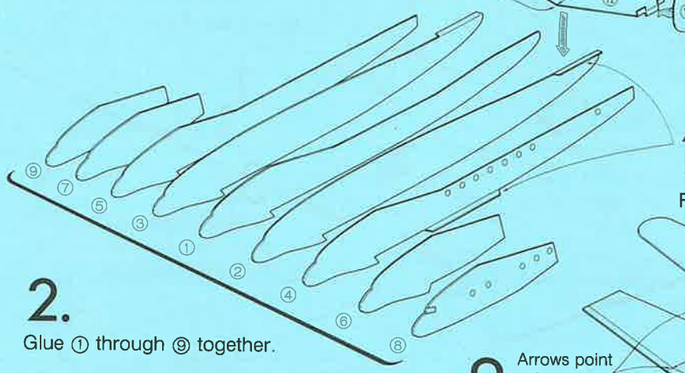


5.
Glue the vertical stabilizers ⑭ and ⑮ to the tabs of the horizontal stabilizer ⑫ aligning the arrows on ⑭ and ⑮ with the folded tab lines of ⑫.

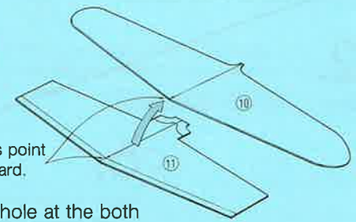
4.
Fold both tabs of the horizontal stabilizer ⑫ as shown.

6.
Glue the tail section (⑫+⑭+⑮) firmly to the fuselage.

1.
Fold all tabs outward.



2.
Glue ① through ⑨ together.



9.
Arrows point forward.
Make a pinhole at the both ends of the center line on the top side of the main wing. Turn the main wing over. Link the pinholes together with a ruler and draw a center line on the bottom side of the main wing.

3.
Glue ⑪ to the underside of ⑩. When dry, cut off the protruding portions.

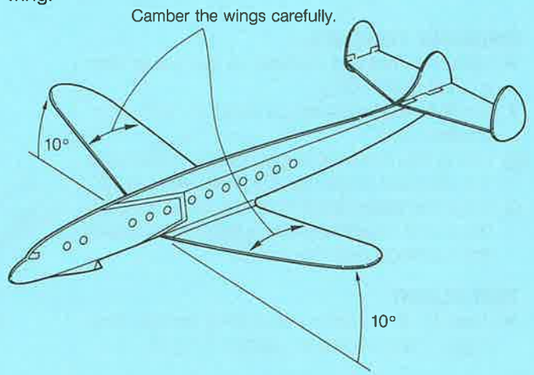
10.
Place a ruler along the center line of the main wing (⑩+⑪) and make a dihedral angle of approximately 10°. Then glue it firmly to the fuselage.

FINISHING TOUCHES
- Give the finishihg touches to the plane after it dries thoroughly.

11. Camber the main wings carefully with your fingers.
12. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 10°.
13. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

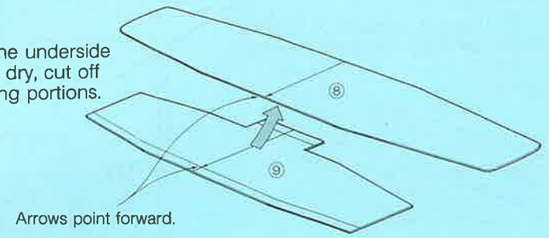
Camber the wings carefully.



Whitewings
Lockheed C130 HERCULES

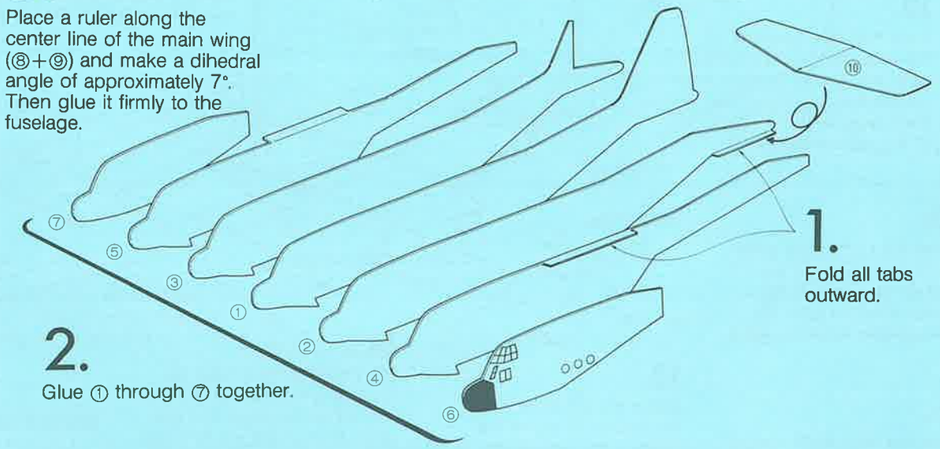
GLUING INSTRUCTIONS
Glue the parts together in the order indicated.

3.
Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.



4.
Turn the horizontal stabilizer ⑩ upside down and glue ⑩ to the fuselage aligning the center line on ⑩ with the center of the fuselage.

5.
Place a ruler along the center line of the main wing (⑧+⑨) and make a dihedral angle of approximately 7°. Then glue it firmly to the fuselage.



1.
Fold all tabs outward.

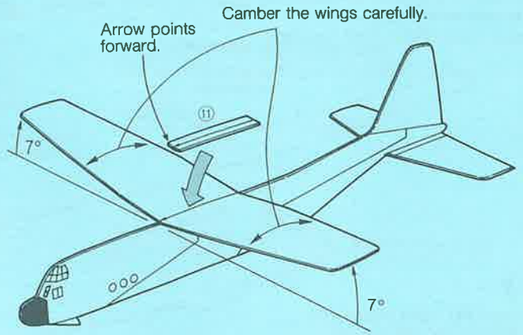
2.
Glue ① through ⑦ together.

FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

6. Camber the main wings carefully with your fingers.
7. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 7°.
8. Fold ⑪ up slightly along the center line and glue it onto the center of the main wing.
9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

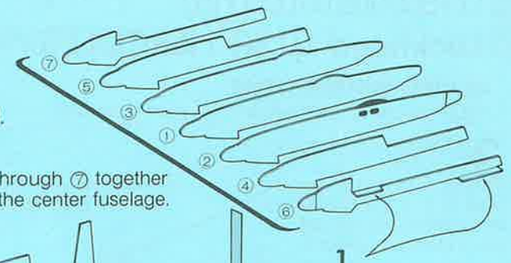
TEST FLIGHT
- Test fly the plane according to the Test Flight instructions on pages 11 to 13.

Camber the wings carefully.
Arrow points forward.



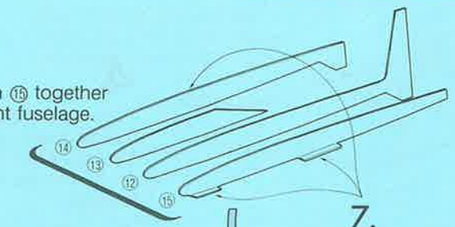
Whitewings
"VOYAGER"

GLUING INSTRUCTIONS
Glue the parts together in the order indicated.



2.
Glue ① through ⑦ together to make the center fuselage.

1.
Fold the tabs outward.

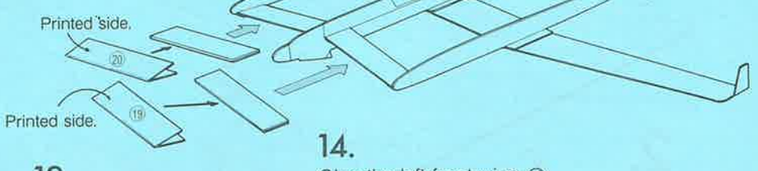


8.
Glue ⑫ through ⑮ together to make the right fuselage.

10.
Glue the center fuselage to the main wing. Make sure to align the center line on the bottom side of the main wing with the center of the fuselage.

12.
Glue the right fuselage to the main wing. Make sure to align the gluing position line on the bottom side of the main wing with the center of the right fuselage.

7.
Fold the tabs outward.



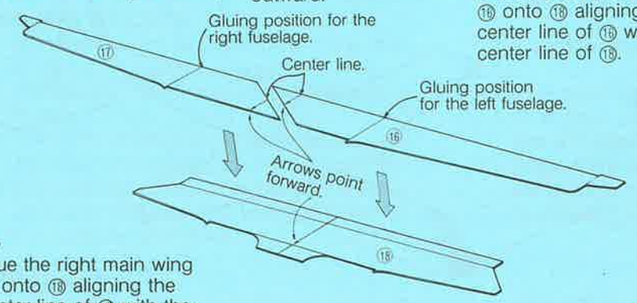
15.
Make the right front wing by folding ⑳ along the dashed line and gluing together. Make sure the printed side faces outward.

14.
Glue the left front wing ⑲ on top of the tabs between the center fuselage and the nose area of the left fuselage.

13.
Make the left front wing by folding ⑲ along the dashed line and gluing together. Make sure the printed side faces outward.

16.
Glue the right front wing ⑳ on top of the tabs between the center fuselage and the nose area of the right fuselage.

4.
Glue the left main wing ⑯ onto ⑱ aligning the center line of ⑯ with the center line of ⑱.



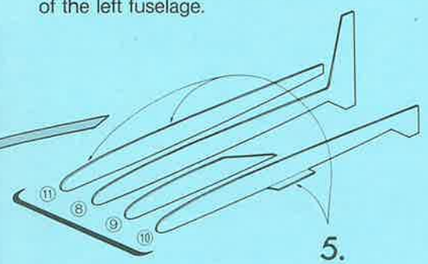
3.
Glue the right main wing ⑰ onto ⑱ aligning the center line of ⑰ with the center line of ⑱.

9.
Make a pinhole at both ends of the gluing position on the main wing for both the right and left fuselage. Turn the main wing over. Link the pinholes together with a ruler and draw a gluing position line on the bottom side of the main wing. Follow the same procedure this time making the pinholes at both ends of the center line on the main wing.

After a 9 day and 25,012 mile flight around the world, non-stop on a single load of fuel, Dick Rutan and Jeana Yeager landed the Voyager in the record books on December 23, 1987. This revolutionary plane took an incredible 22,000man hours to construct and is the only long range, fuel efficient aircraft of its type in the world.

Wing Span	110.8 ft.
Fuselage Length	25.4 ft.
World Flight Take-off Wt.	11,326 lbs.
Fuel Wt. (1,489 gal.)	8,934 lbs.

11.
Glue the left fuselage to the main wing. Make sure to align the gluing position line on the bottom side of the main wing with the center of the left fuselage.



17.
Fold up both ends of the main wing at a 90° angle along the dashed line.

5.
Fold the tabs outward.

6.
Glue ⑧ through ⑪ together to make the left fuselage.

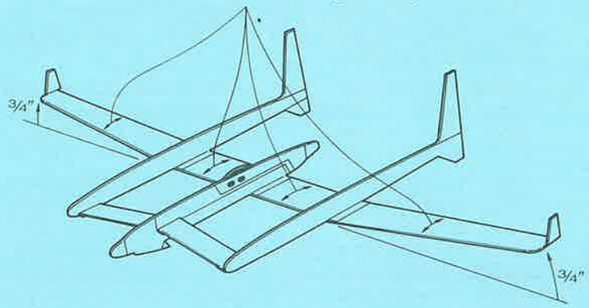
FINISHING TOUCHES
- Give the finishing touches to the plane after it dries thoroughly.

18. Camber the main wings carefully with your fingers.

19. Bend the main wings up slightly at the joints of both the right and left fuselage to make the dihedral angle for the main wing. The wing tips should be raised about 2cm (3/4″) from the horizontal level.

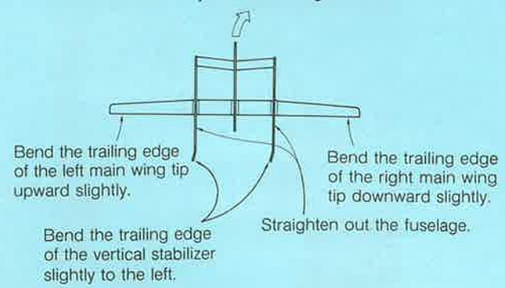
20. View the plane from both the front and the back and straighten any warps or bends in the fuselages and the wings.

Camber the wings carefully.



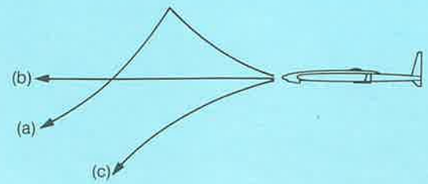
TEST FLIGHT
Try to test fly your plane when there is as little wind as possible. Throw the plane gently either horizontally or slightly downward. Adjust it in the order indicated to ensure a straight flight.

1. When the plane curves right


Bend the trailing edge of the left main wing tip upward slightly.
Bend the trailing edge of the right main wing tip downward slightly.
Straighten out the fuselage.
Bend the trailing edge of the vertical stabilizer slightly to the left.

***If it curves left, make the reverse adjustment.**

2. When the nose goes up or down.
(a) Bend the trailing edges of the front wing slightly upward.
(b) Ideal.
(c) Bend the trailing edges of the front wing slightly downward.



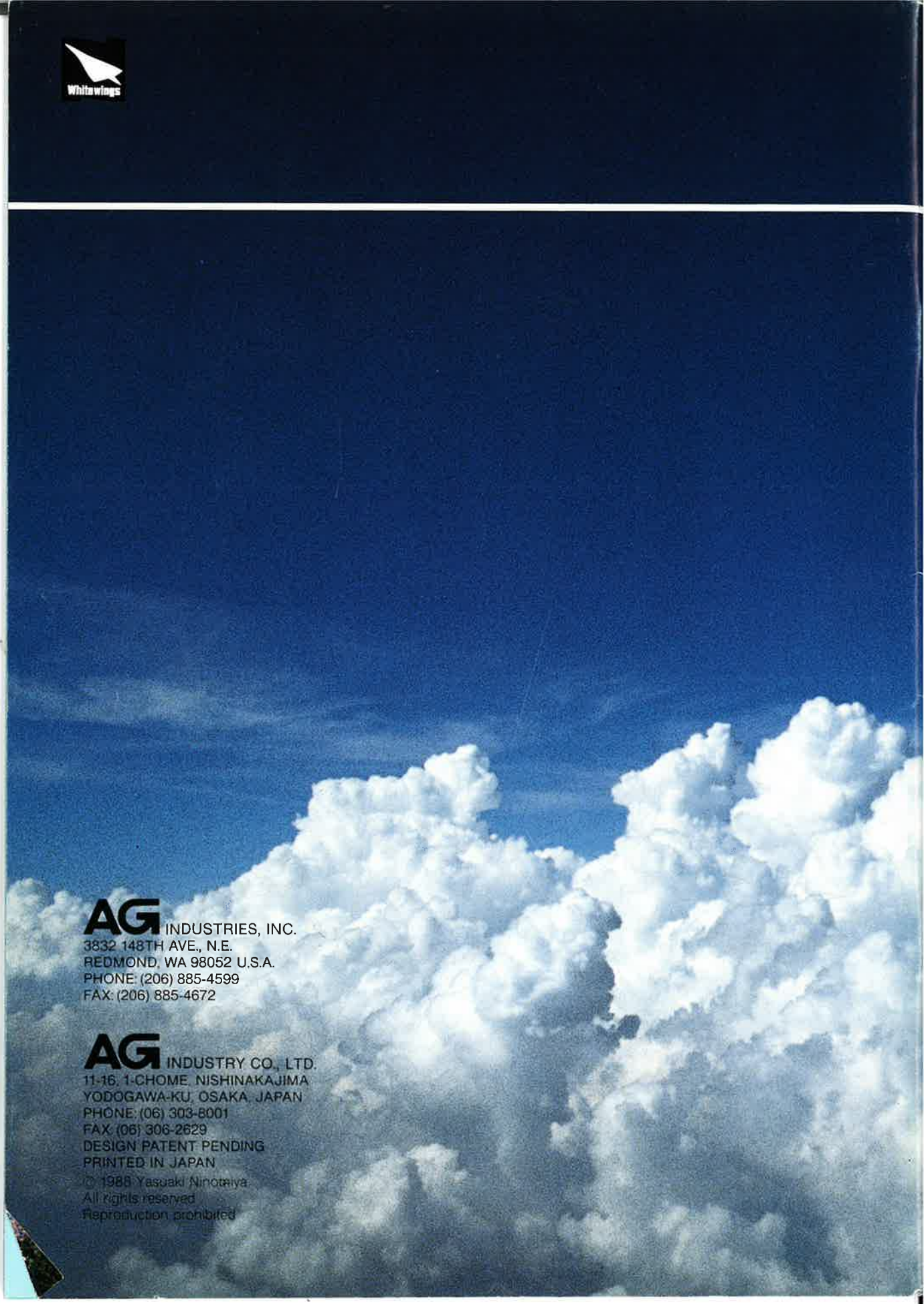
■ DESIGNER'S PROFILE

Dr. Yasuaki Ninomiya, born in 1926, has been fascinated by airplanes since early childhood, an interest which later developed into his present hobby and business of designing and building paper airplanes.

He received his doctorate in 1962 in the field of microwave measurement theory. He is recognized as a pioneer in microcommunications engineering from his work as a leading researcher at the Electrical Communications Laboratory of the Nippon Telegraph and Telephone Corporation from which he retired in 1984. At the invitation of the Iranian government, he served as principal advisor of the joint Japan-Iran Electronic Communications Research Center from 1975 to 1977. He is currently a member of the Japan Industrial Designer's Association and has been a member of the Good Design Committee of the Ministry of International Trade and Industry.

Drawing upon this distinguished background and expertise, Dr. Ninomiya designs aviationally sound and sleek, high performance paper planes based upon principles of industrial design and mechanical functionality. Convincing evidence of his talent is his garnering of the grand prizes in the Duration Flight and Distance Flight categories of the 1st International Paper Plane Contest (Pacific Basin Division) in San Francisco in 1967. He later served as a judge in the 2nd Great International Paper Plane Contest, held in Seattle, Washington in May 1985.

Dr. Ninomiya is widely recognized as a respected authority on paper planes. He has designed a wide variety of planes ranging from the AG075 SPACE SERIES composed of heavy-duty styrene, the AG600 SERIES comprised of 6 excellent gliders featuring a pre-cut balsa body, the AG100 SERIES which are individually packaged models from the AG600 SERIES, the AG1500 ORIGINAL SERIES and AG1501 COLLECTION SERIES, to this AG1502 HERITAGE SERIES. His 8 volume publication, "Collection of High Performance Paper Planes", has sold over 3 million copies. He also holds a private plane operator's license and tries to get into the pilot's seat of his Cessna 182 whenever his busy schedule permits.



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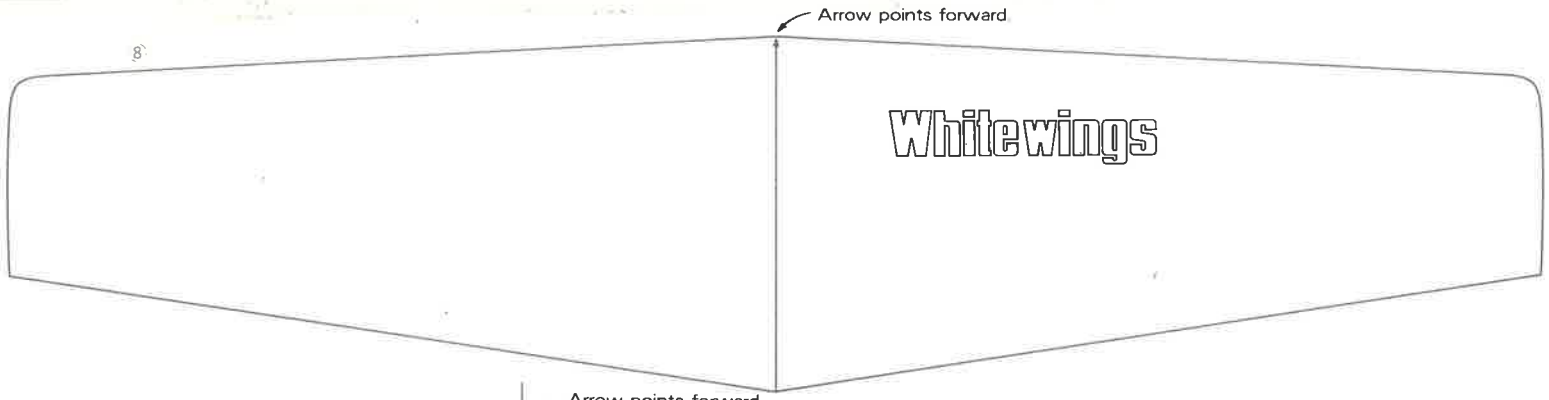

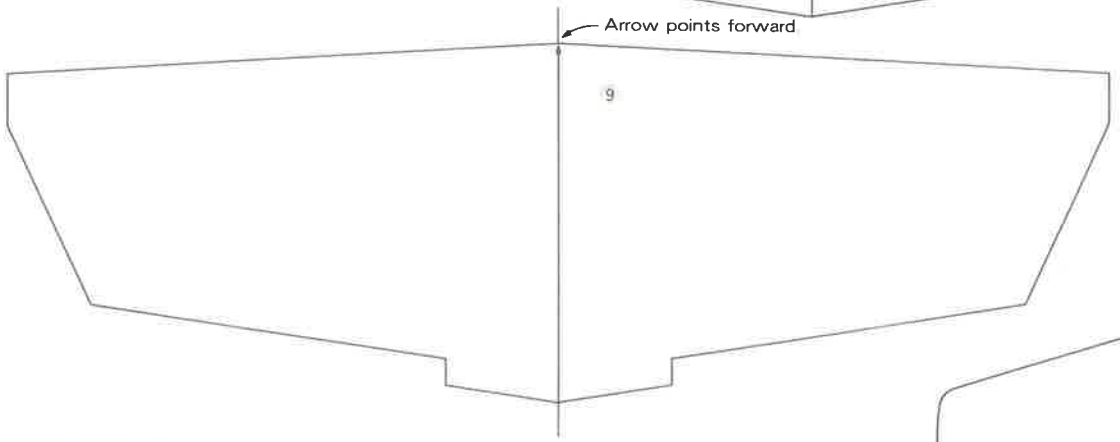

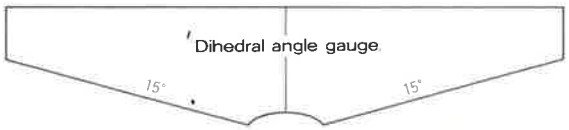

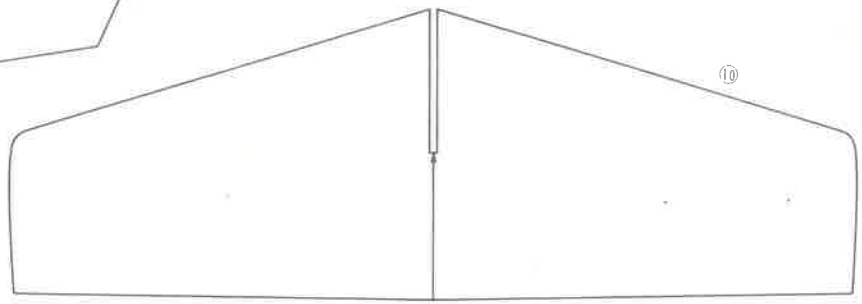

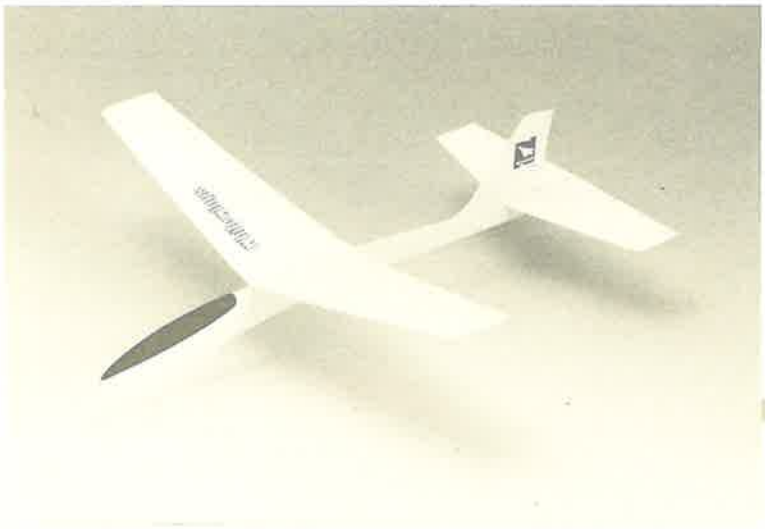

Whitewings®

Racer 519 "PAPPY"

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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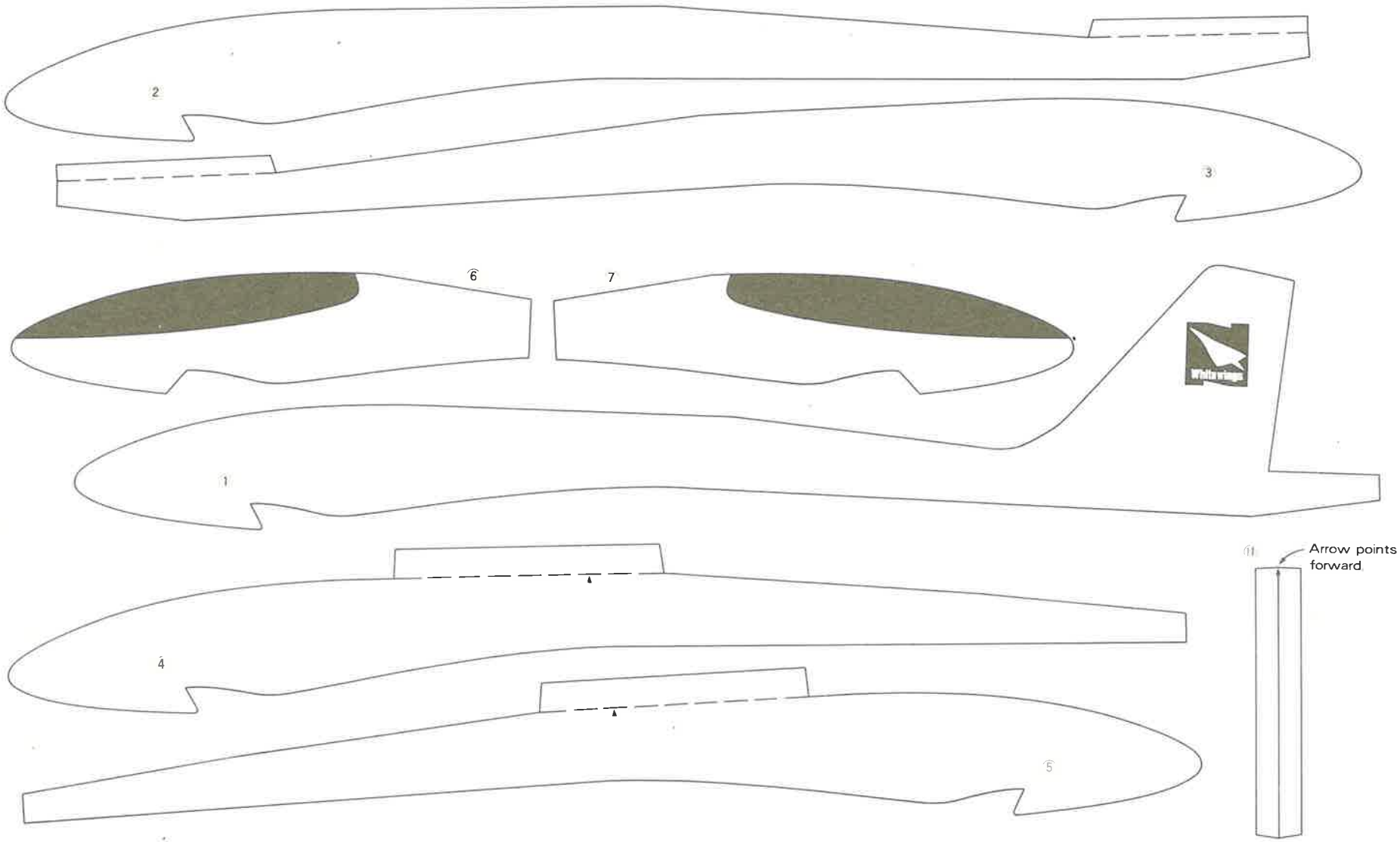
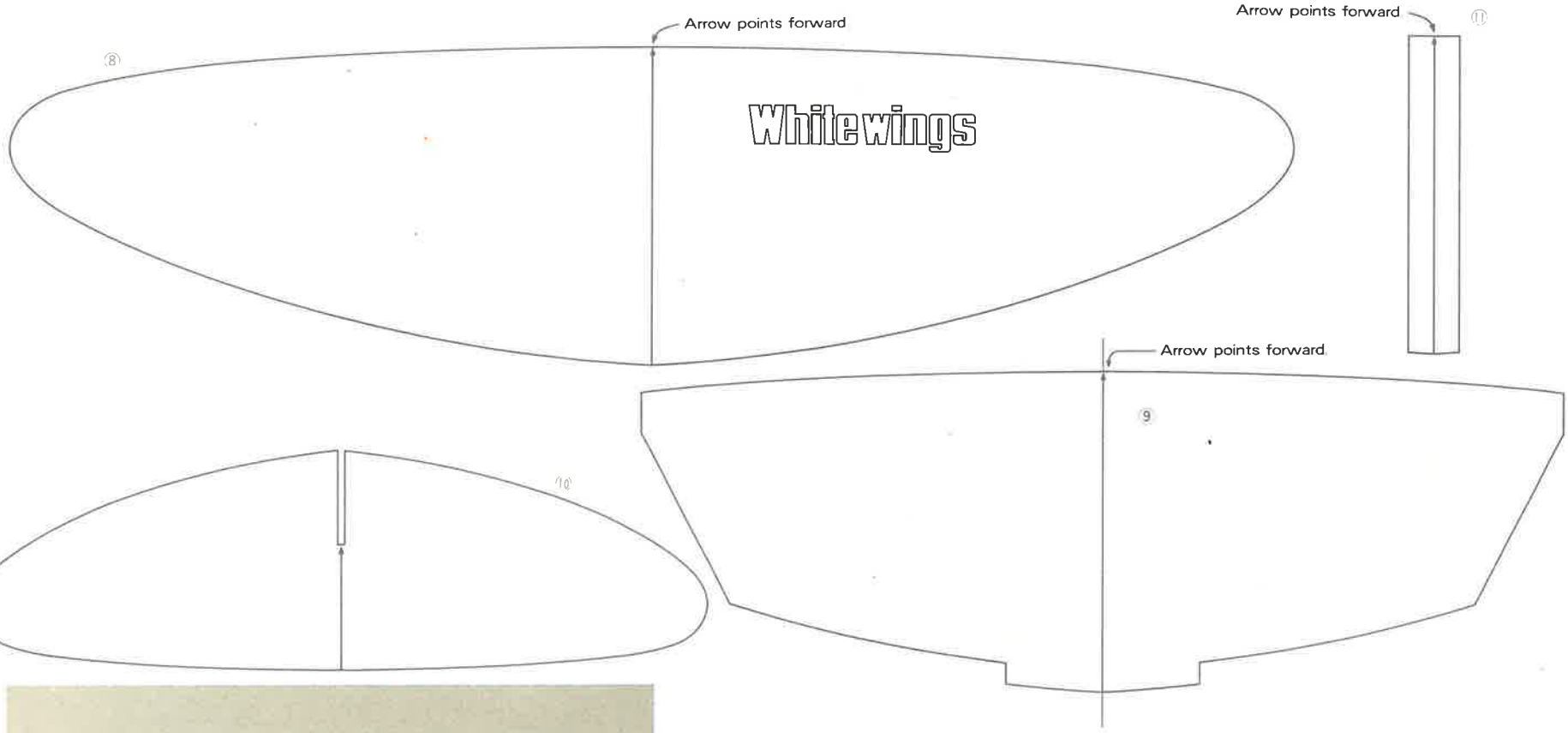
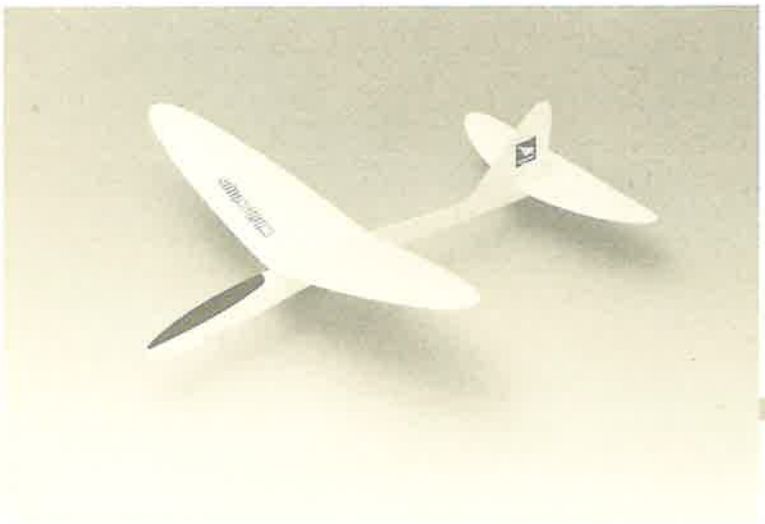

2
3
6
7
1
4
5
11
Arrow points forward





Whitewings®

Racer 520 AMELIA

----- Fold with dashed line inside.
↑ Arrows point forward.

Bend-resistant direction

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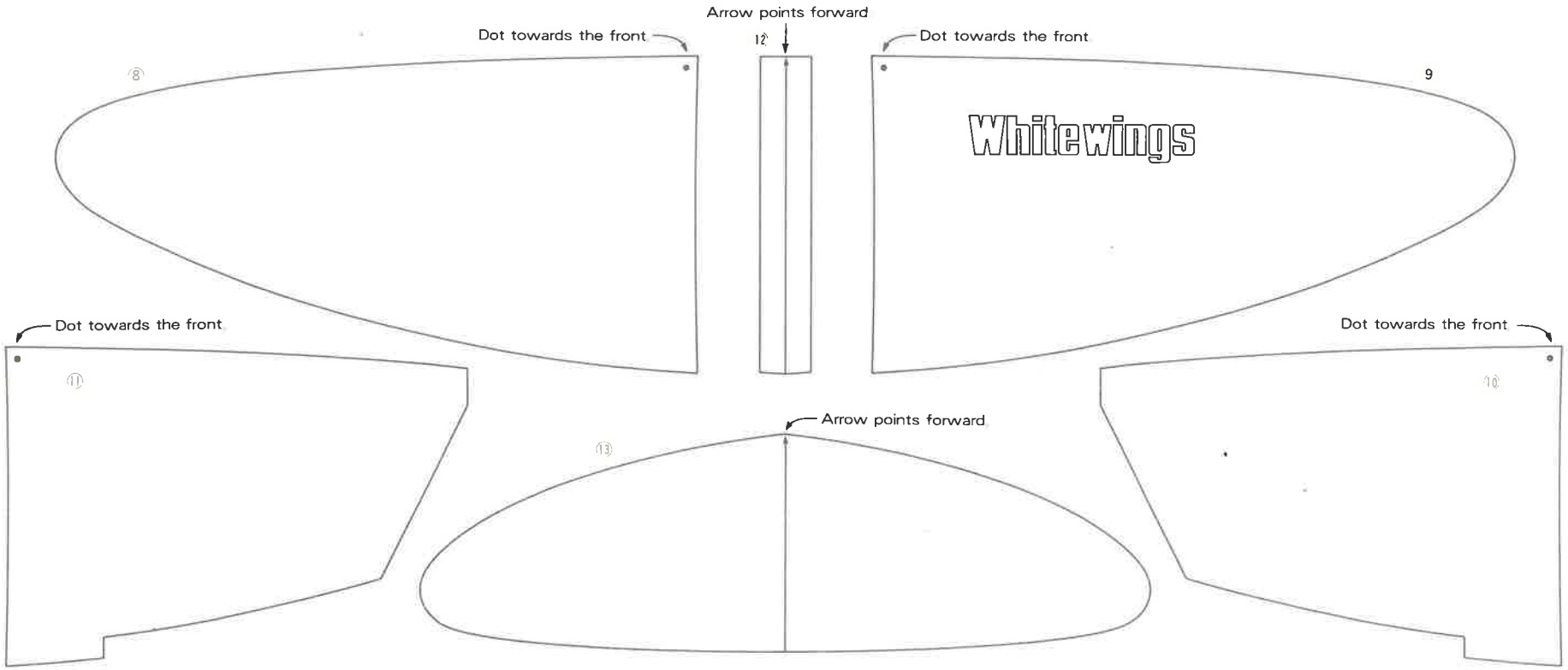
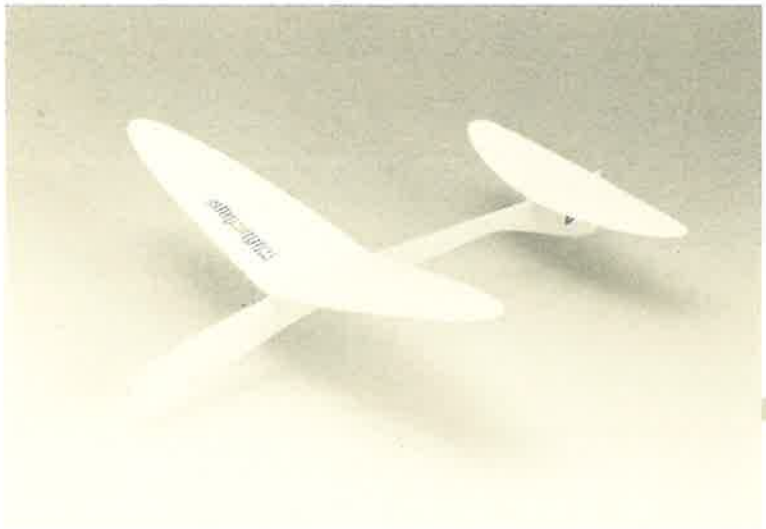
2
3
6
7
1
4
5
Dihedral angle gauge
15°
15°





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Racer 521 JACQUELINE

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Bend-resistant direction

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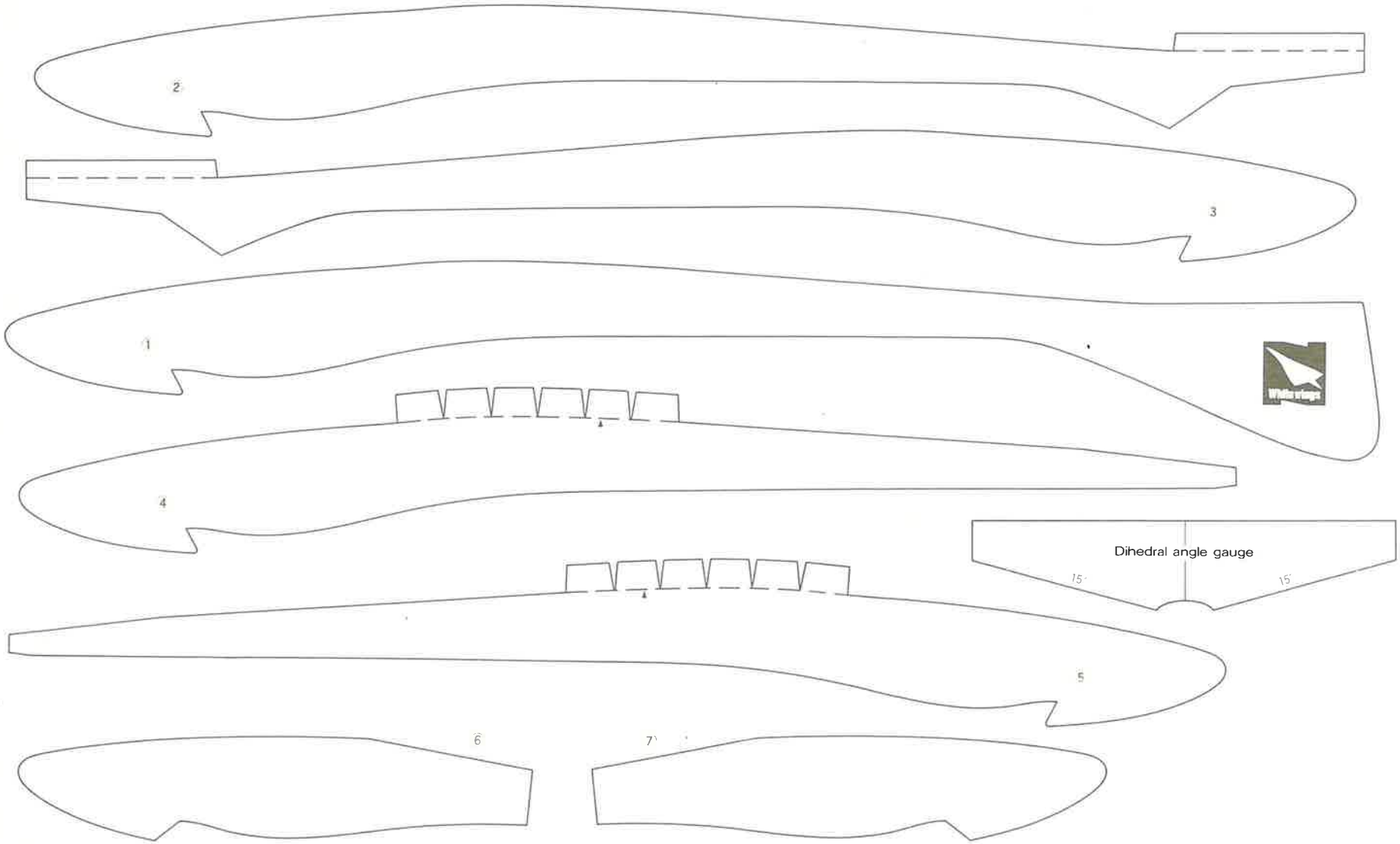
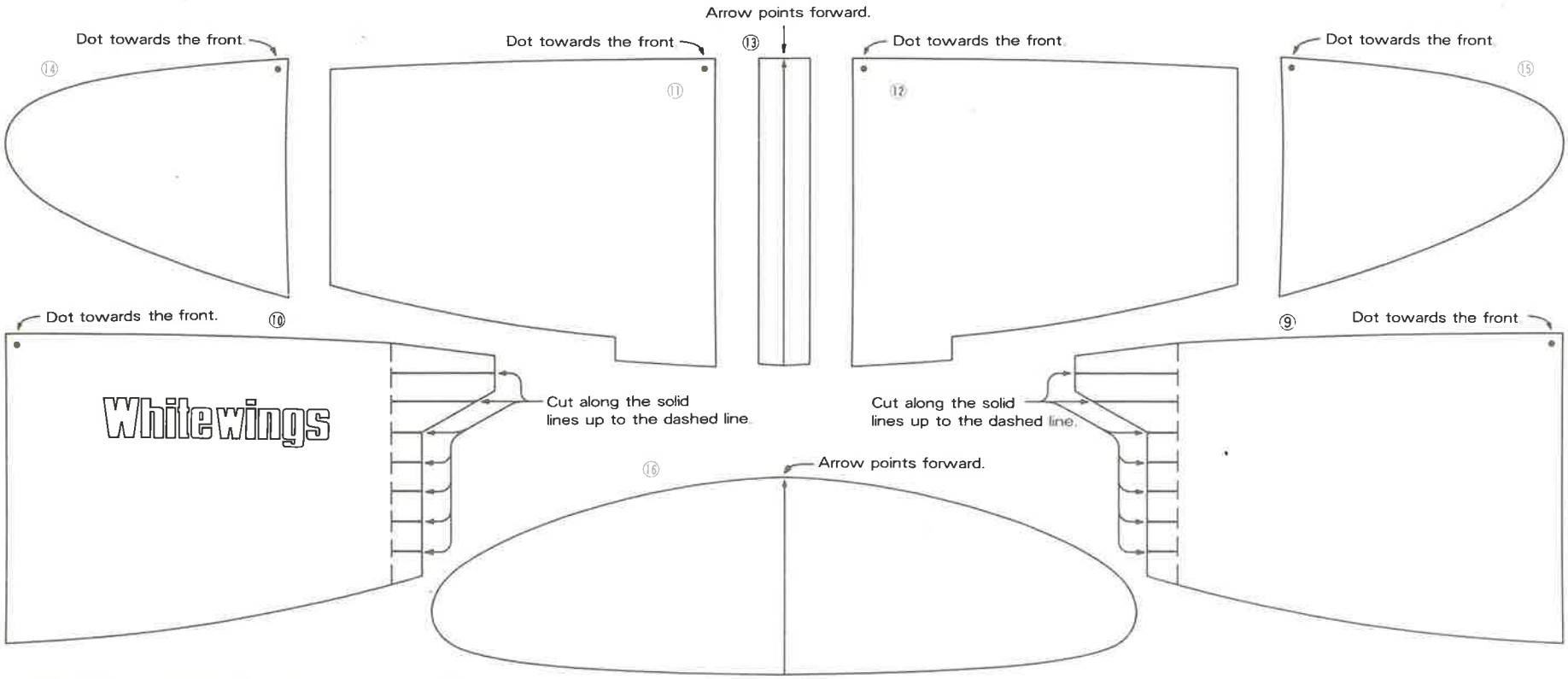
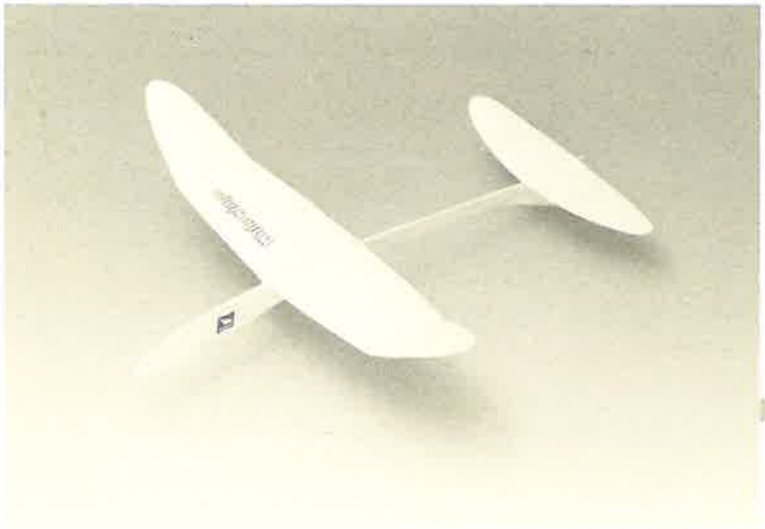

2
3
1
4
Dihedral angle gauge
15°
15°
5
6
7





Whitewings®

Racer 522 RICHARD

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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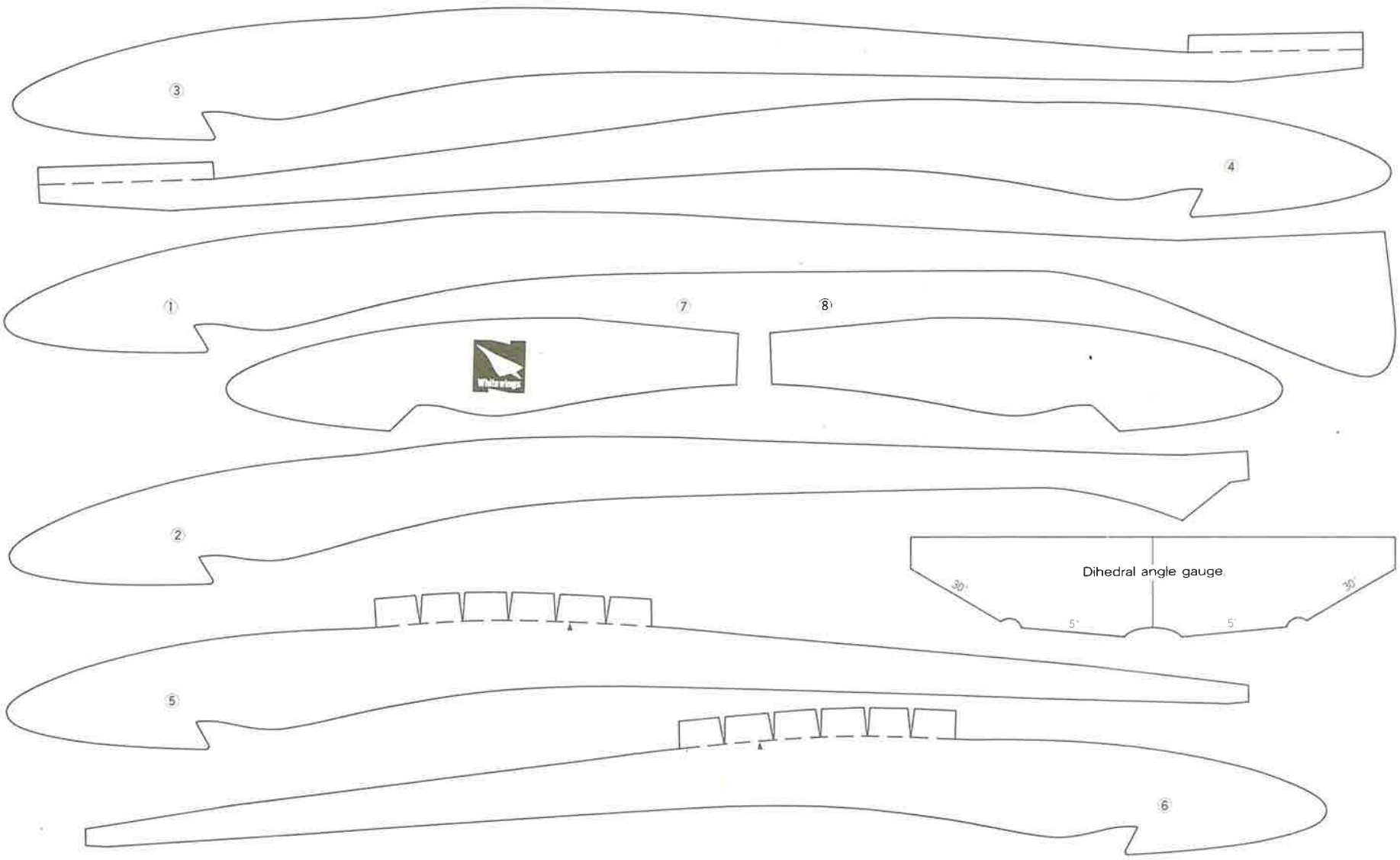
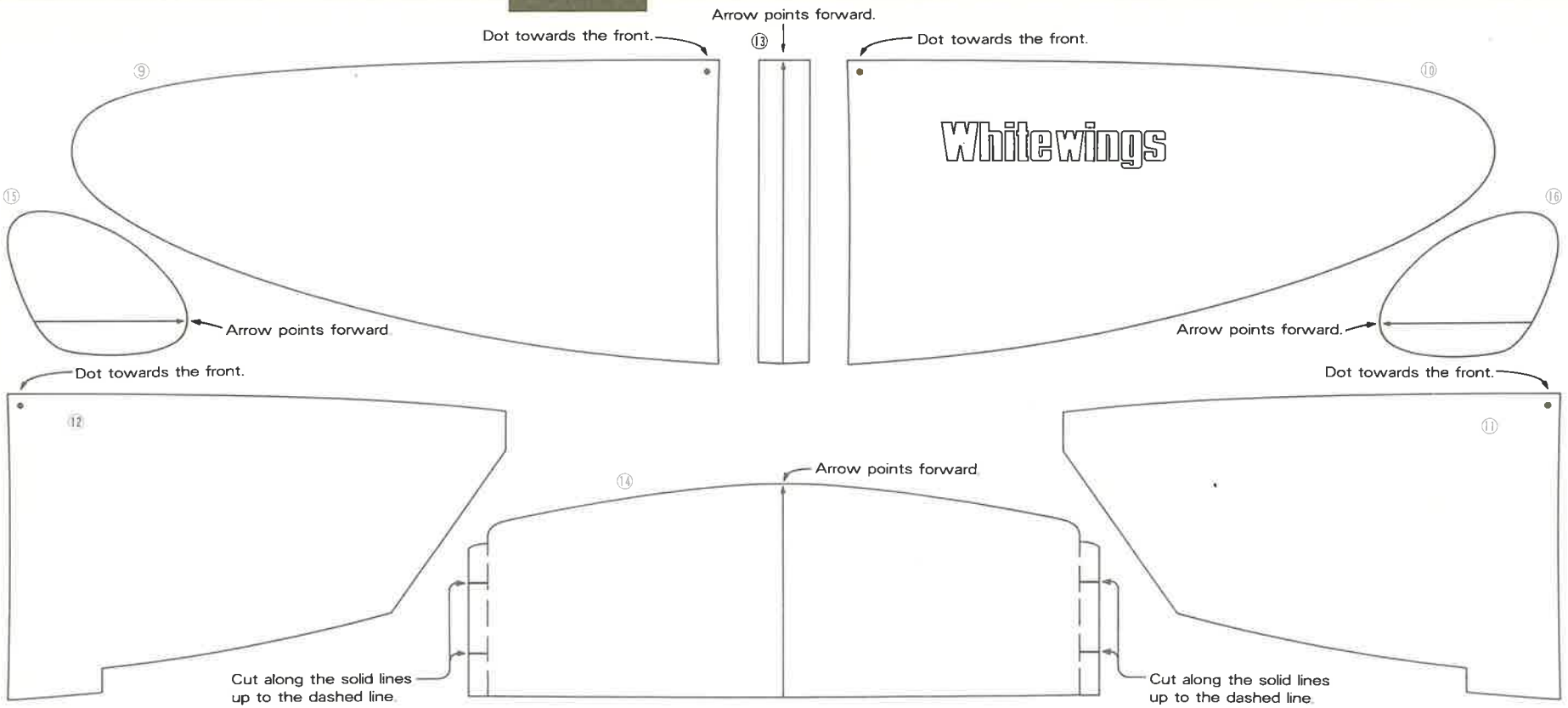

3
4
1
7
8
2
Dihedral angle gauge
30°
5°
5°
30°
5
6



Whitewings®

Racer 523 "BILLY"

- - - - - Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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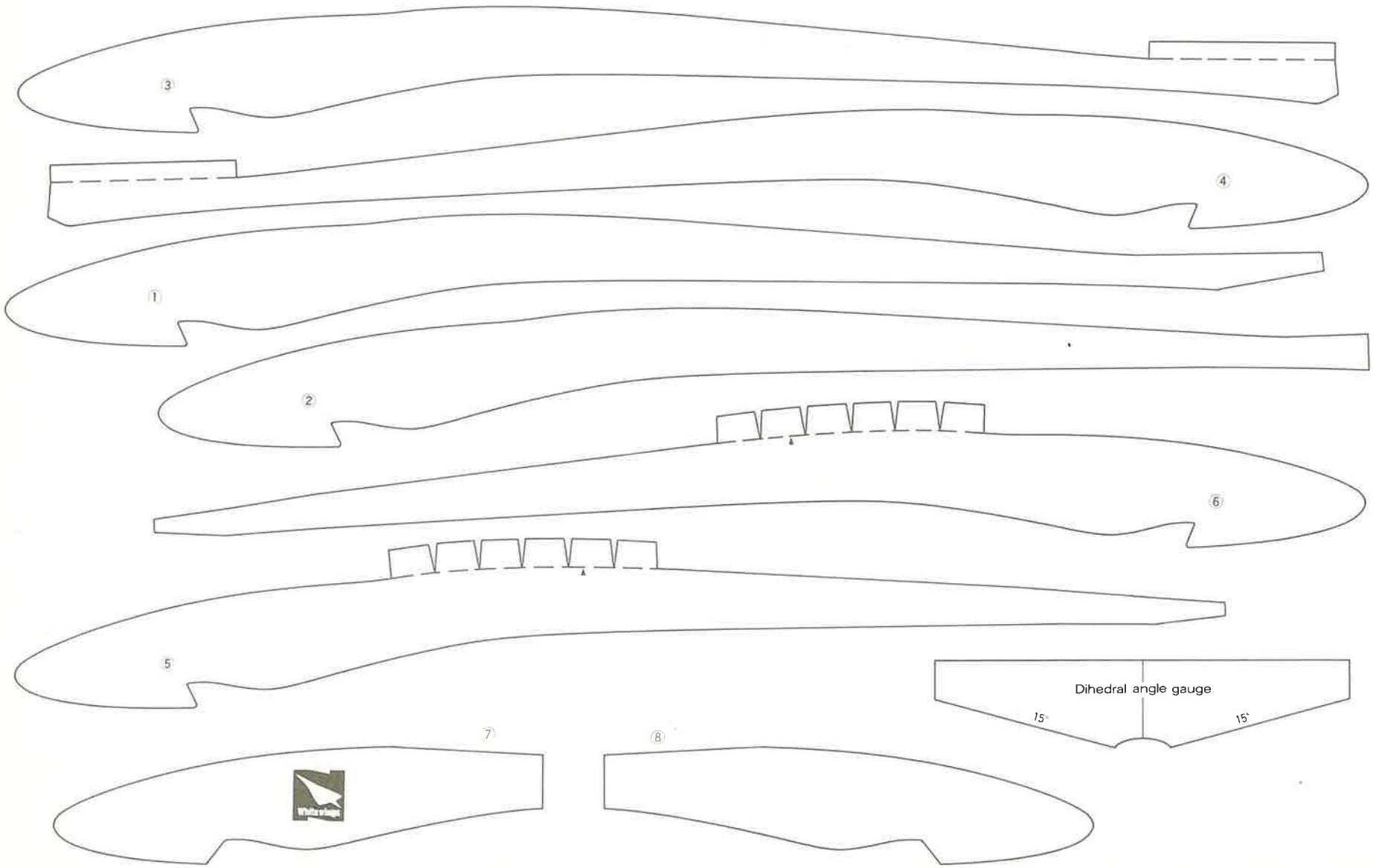

3
4
1
2
6
5
Dihedral angle gauge
15°
15°
7
8

Make firm creases along the dashed lines.

Arrow points forward.

⑥ ⑦

Arrow points forward.

Dihedral angle gauge.

15° 15°

④

Make firm creases along the dashed lines.

make the dihedral angle.

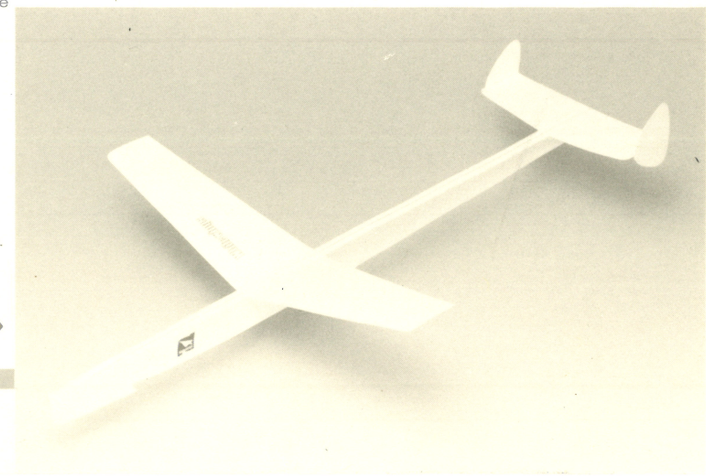
Cut along the solid lines up to the dashed line.

Arrow points forward.

⑤

Cut along the solid lines up to the dashed line.

Arrow points forward.



Whitewings®

TriLinear 701 LINDBERG

Fold with dashed line inside. Arrows point forward.

Bend-resistant direction

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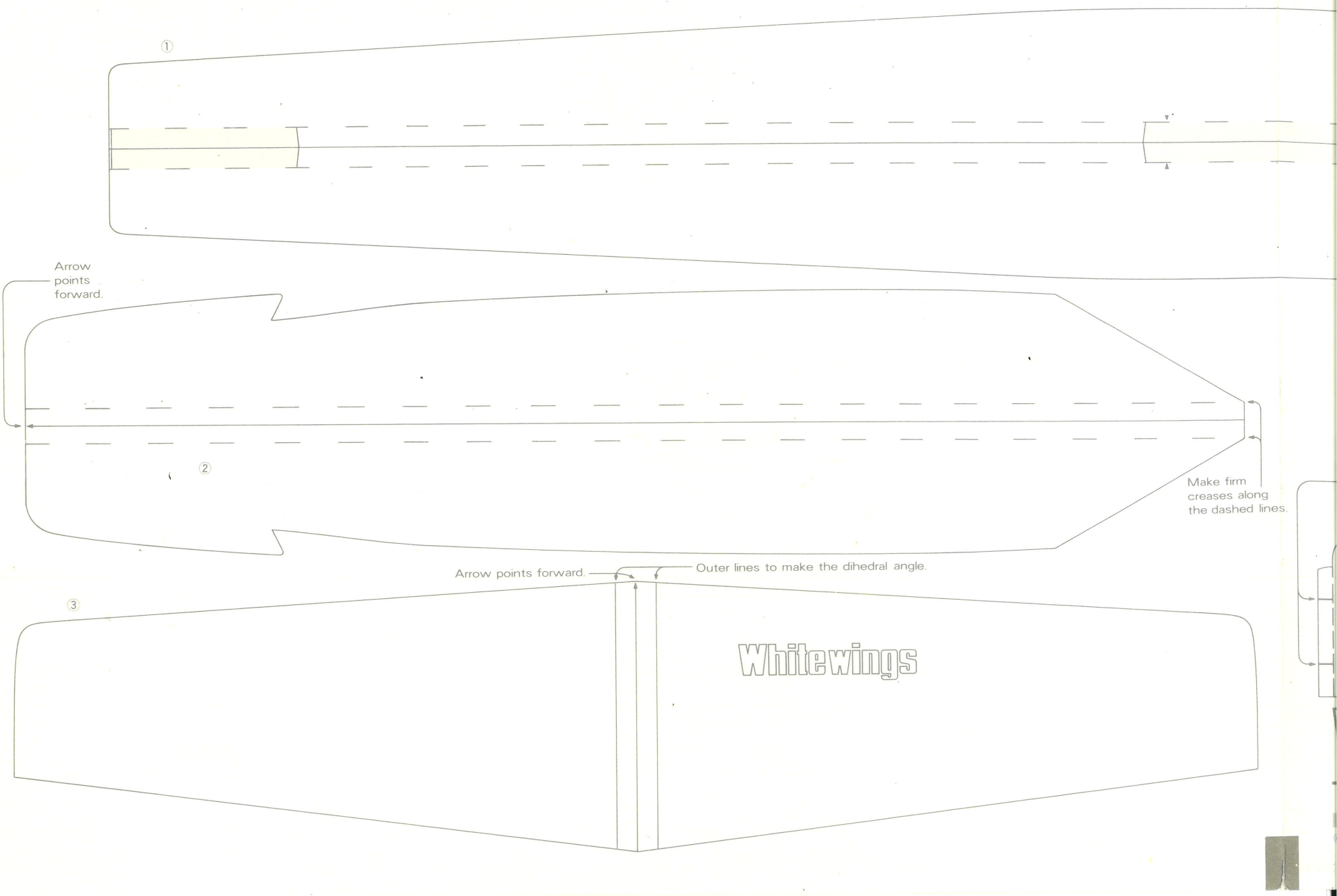

①
Arrow points forward.
②
Make firm creases along the dashed lines.
Arrow points forward.
Outer lines to make the dihedral angle.
③
Whitewings

Make firm creases along the dashed lines

Dihedral angle gauge

15° 15°

b Then fold up along the dashed line at a 90° angle. ⑦

a First cut out the – – – line.

c After folding, trim along the solid line.

Arrow Points forward

Arrow points forward

⑥

Fold the tab along this dashed line

5

Arrow points forward.

4

Arrow points forward.

nes to make the dihedral angle

Arrow points forward

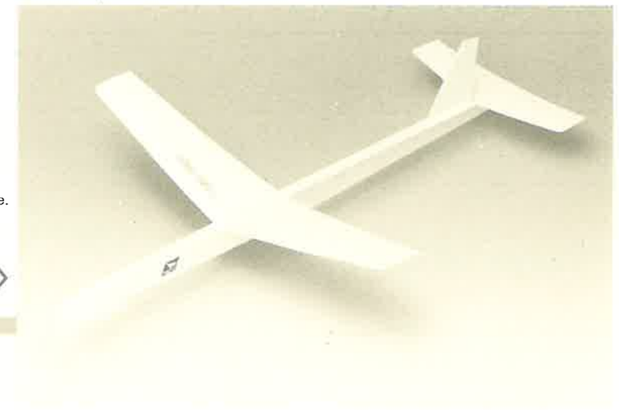
Whitewings

Whitewings

TriLinear 702 RICKENBACKER

Fold with dashed line inside. Arrows point forward.

Bend-resistant direction



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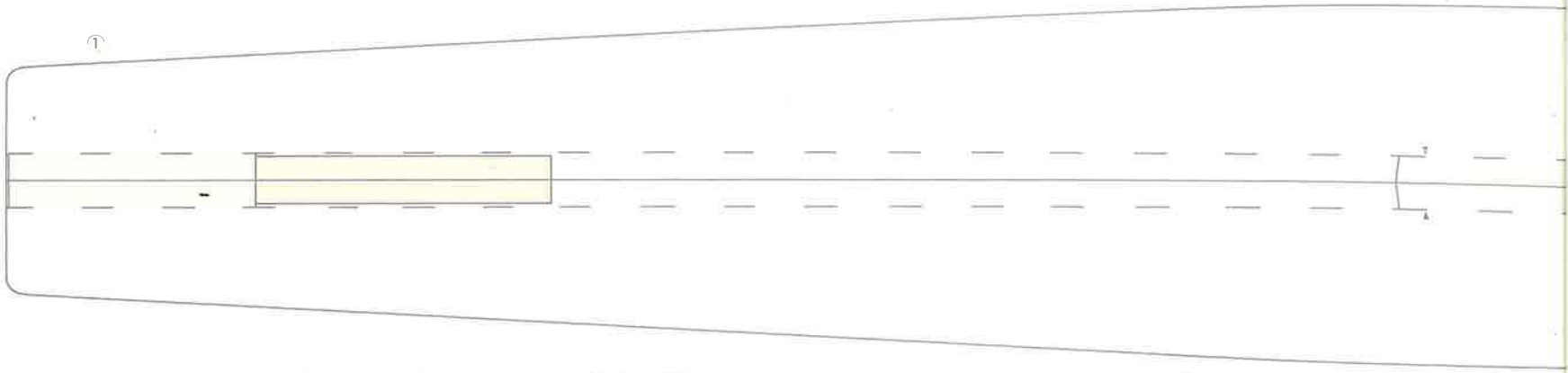
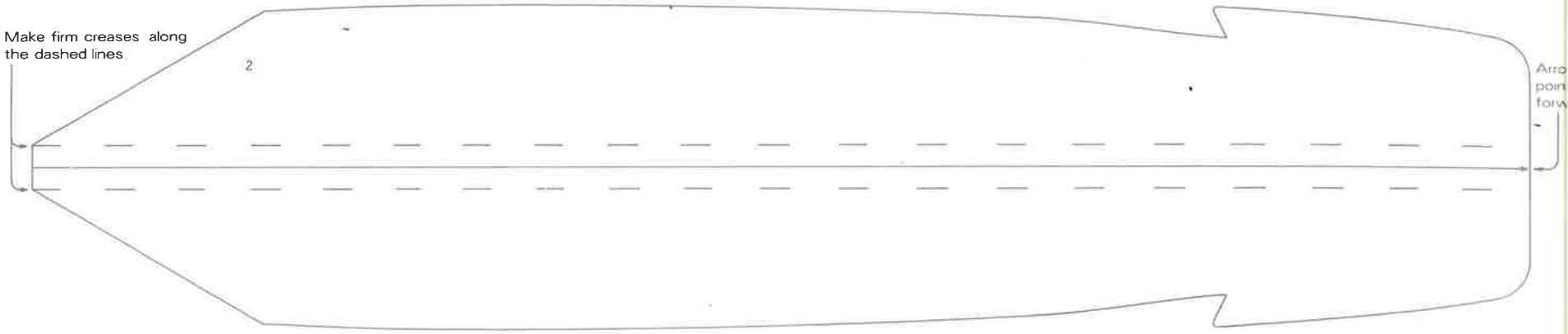
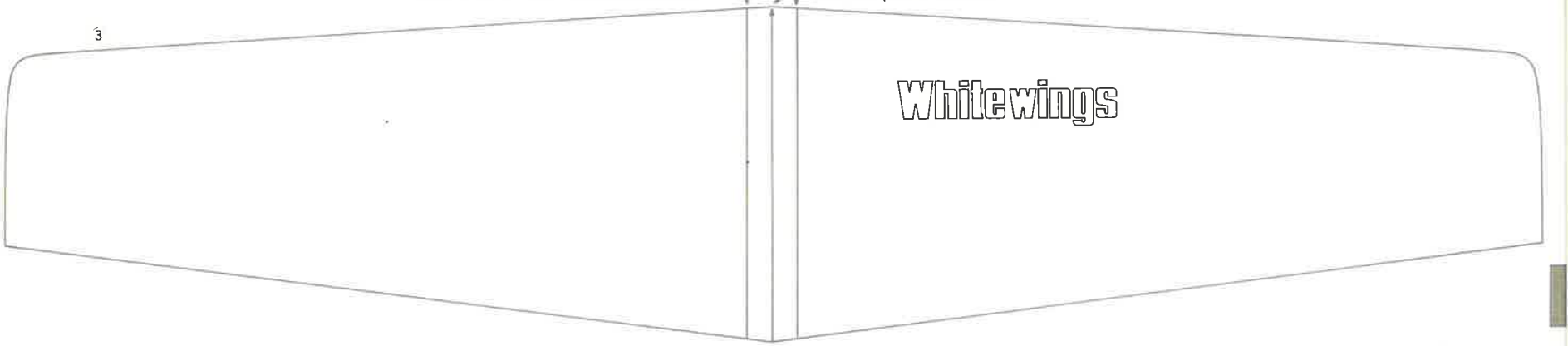

1


Make firm creases along
the dashed lines
2
Arro
poin
forw


Outer lines to make the dihedral angle
Arrow points forward
3
Whitewings

Make firm creases along the dashed lines.

Dihedral angle gauge

15° 15

Arrow points forward.

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

Arrow points forward

7

6

Arrow points forward

Arrow points forward

Arrow points forward

5

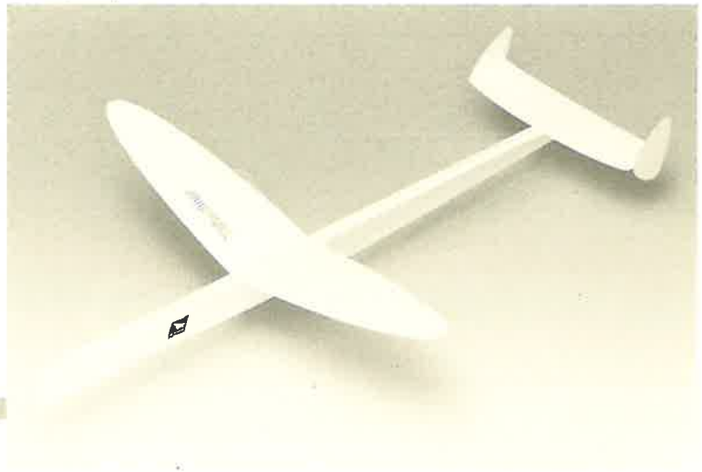
4

Arrow points forward

o make the dihedral angle

hitewings

Cut along the solid lines up to the dashed lines.



Whitewings TriLinear 703 CHENNAULT

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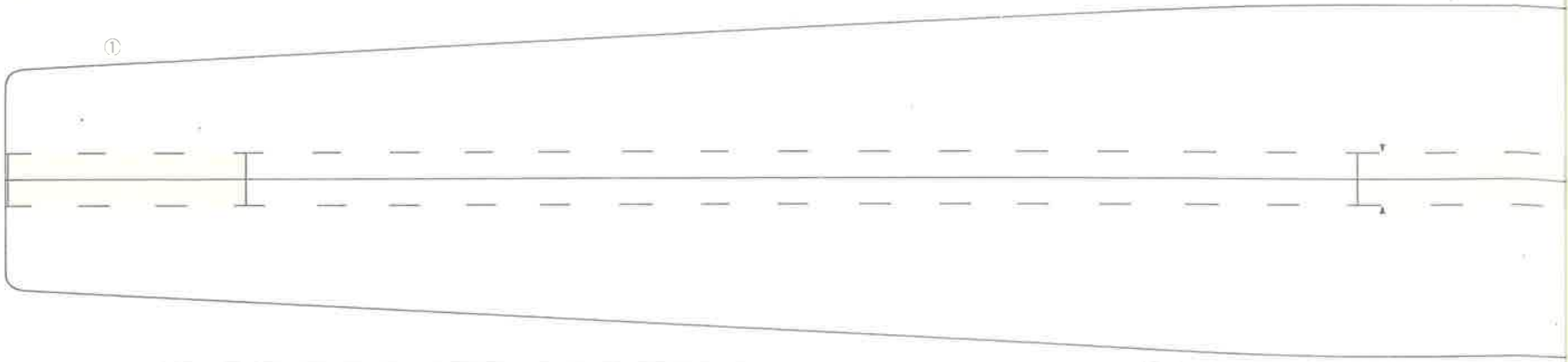
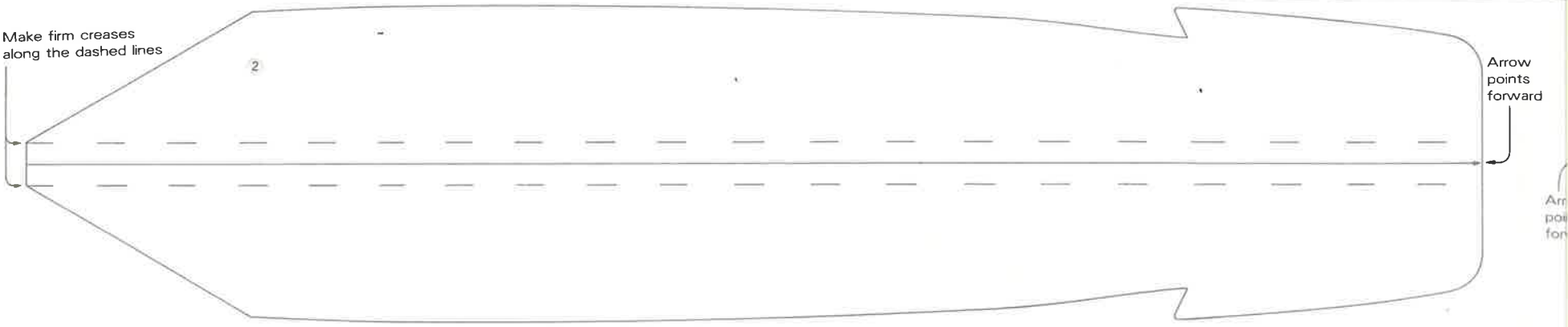
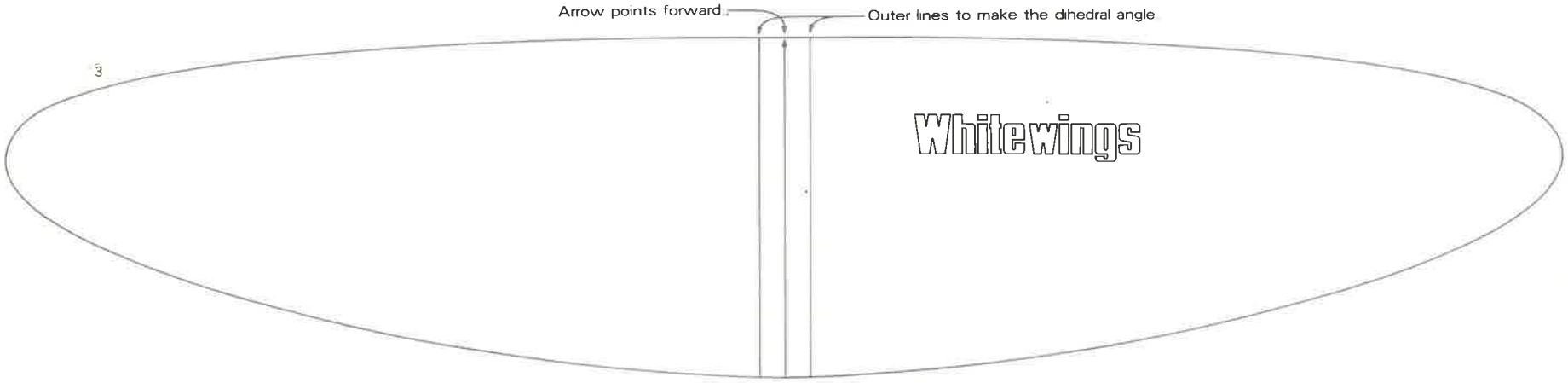
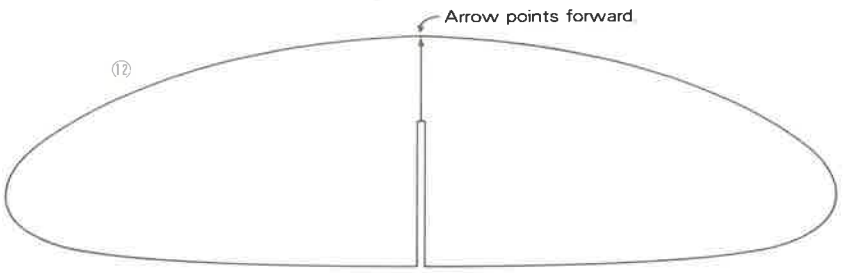
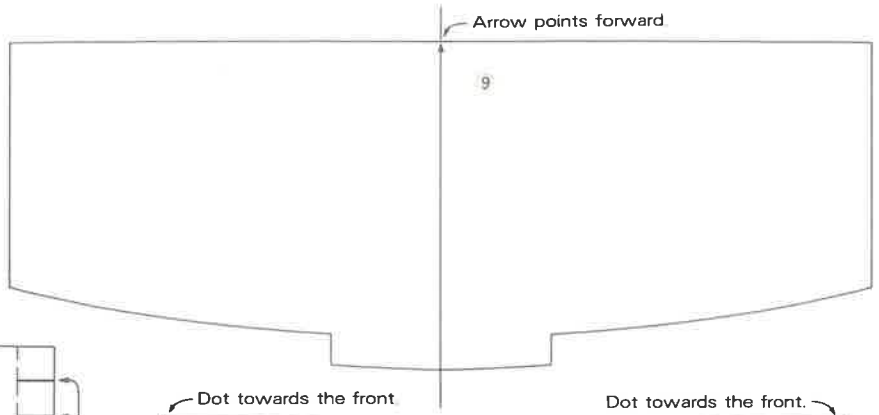
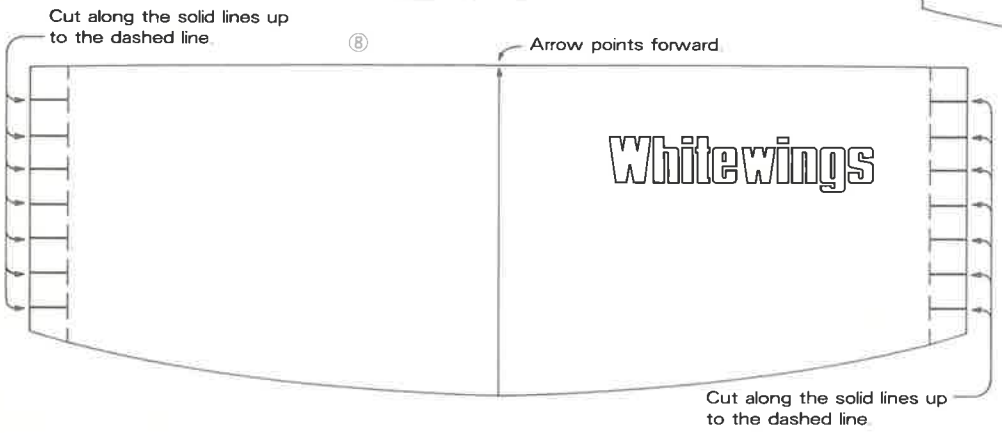

①

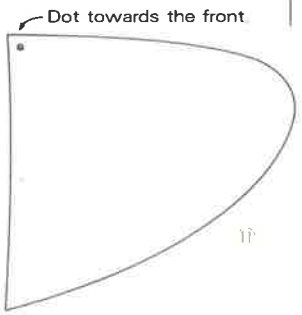

Make firm creases
along the dashed lines
②
Arrow
points
forward

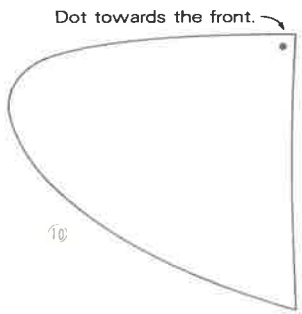

Arrow points forward
Outer lines to make the dihedral angle
③
Whitewings

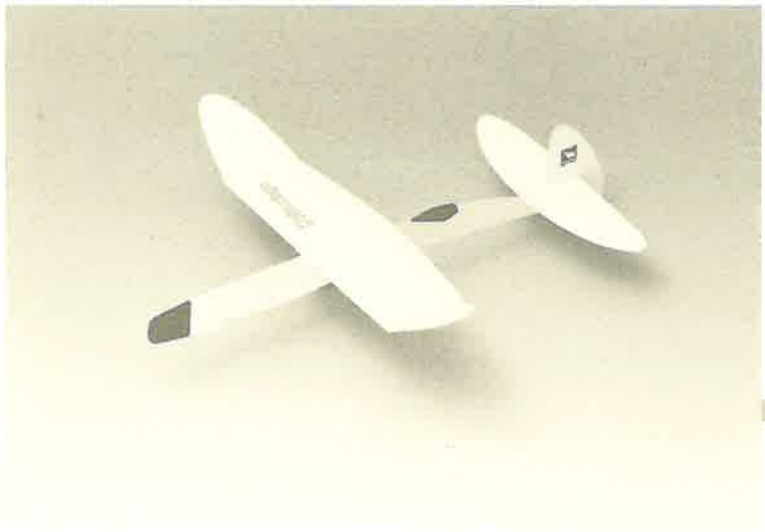





Cut along the solid lines up to the dashed line
⑧
Arrow points forward
Whitewings
Cut along the solid lines up to the dashed line







Whitewings®

Light Plane 305 WILBUR

- - - - - Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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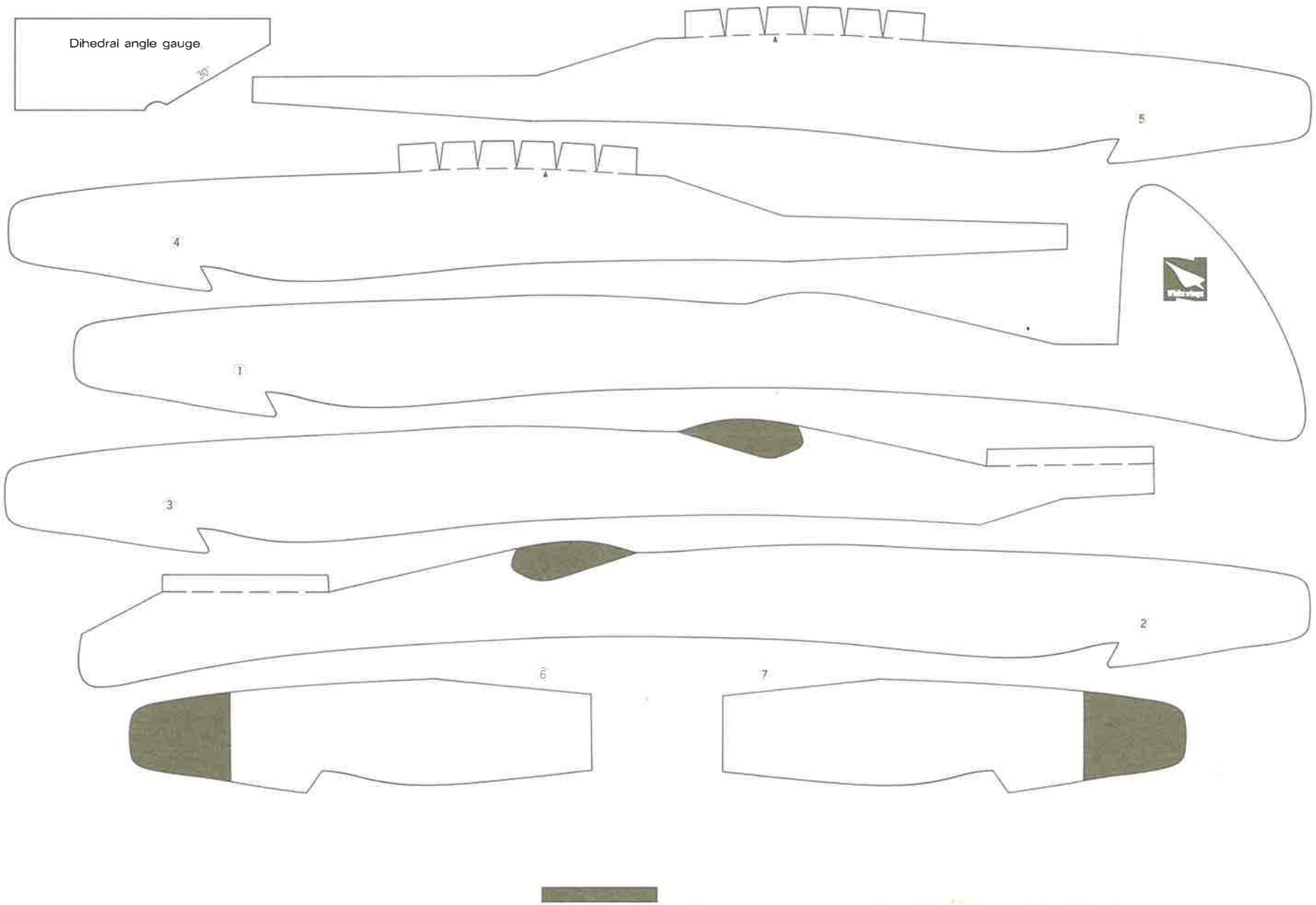
Dihedral angle gauge
30°
5
4
1
3
2
6
7

Dot towards the front

10

Cut along the solid lines up to the dashed line.

8

Arrow points forward

Whitewings

Cut along the solid lines up to the dashed line.

Dot towards the front.

11

Arrow points forward

9

Arrow points forward.

13

Arrow points forward

12

Dihedral angle gauge

35

Whitewings®

Light Plane 306 ORVILLE

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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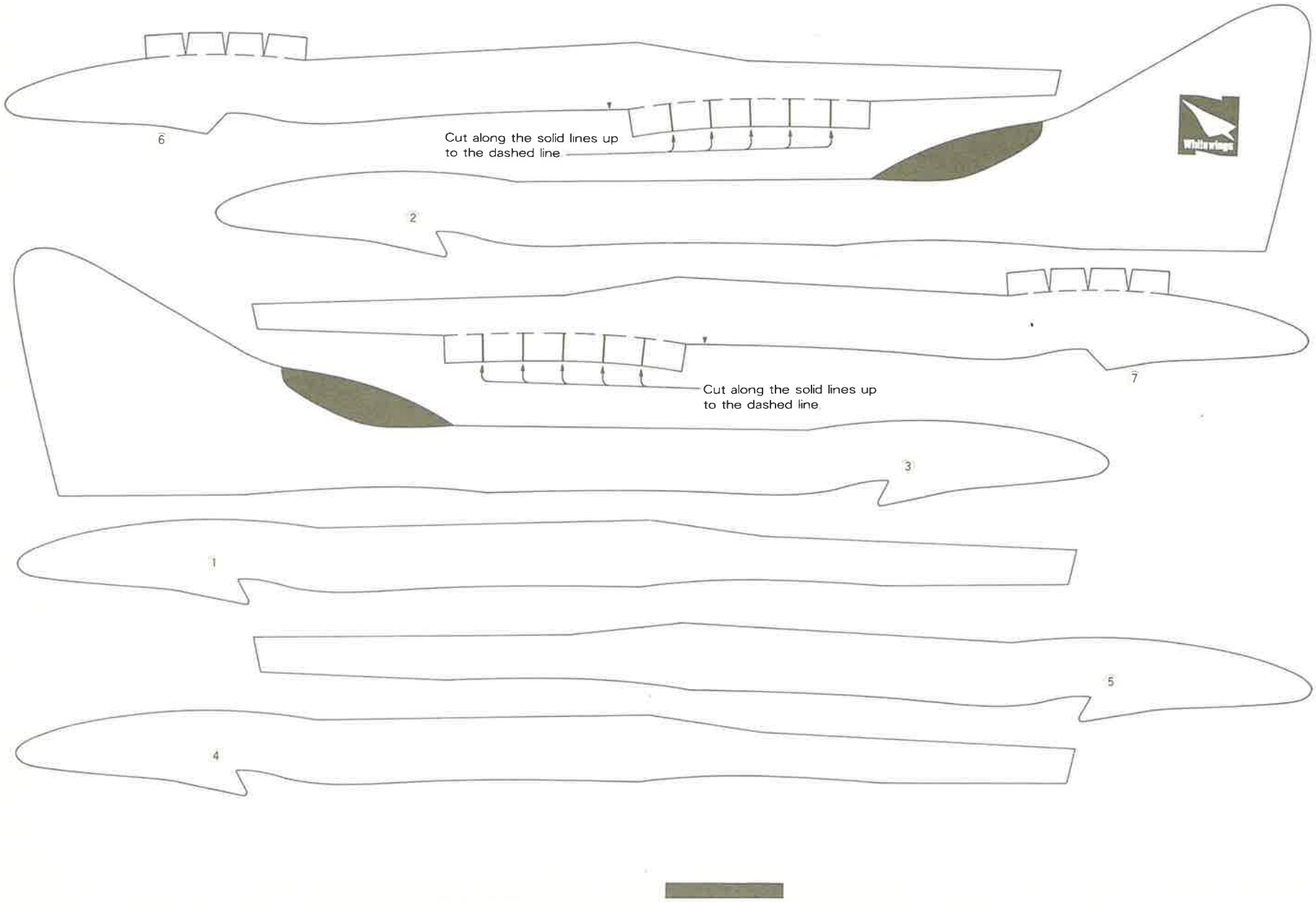
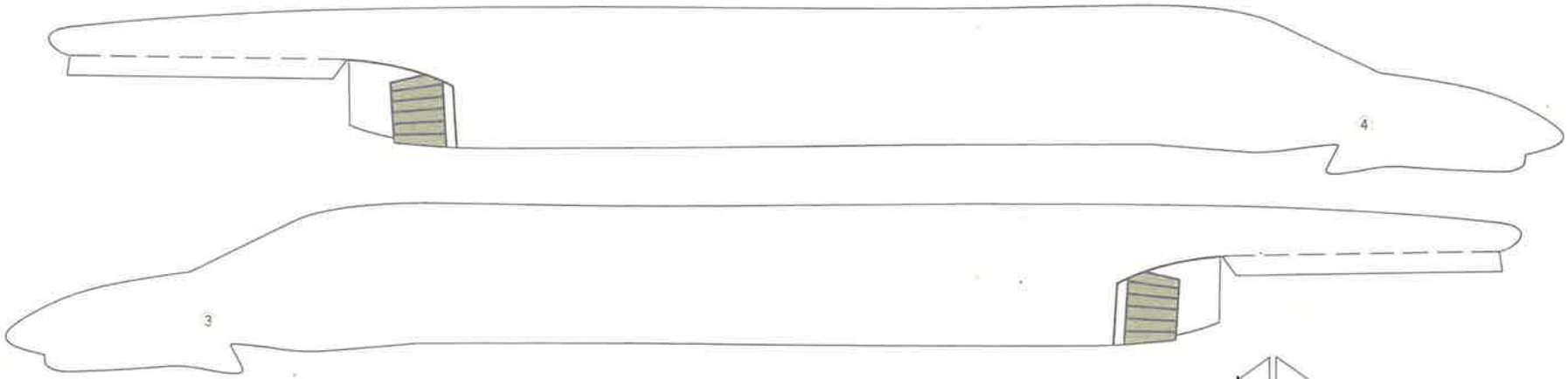
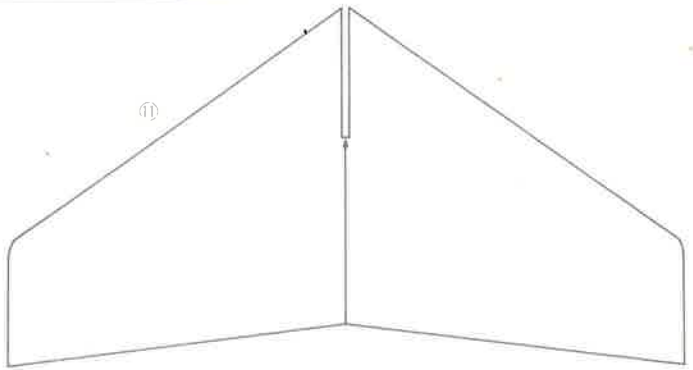
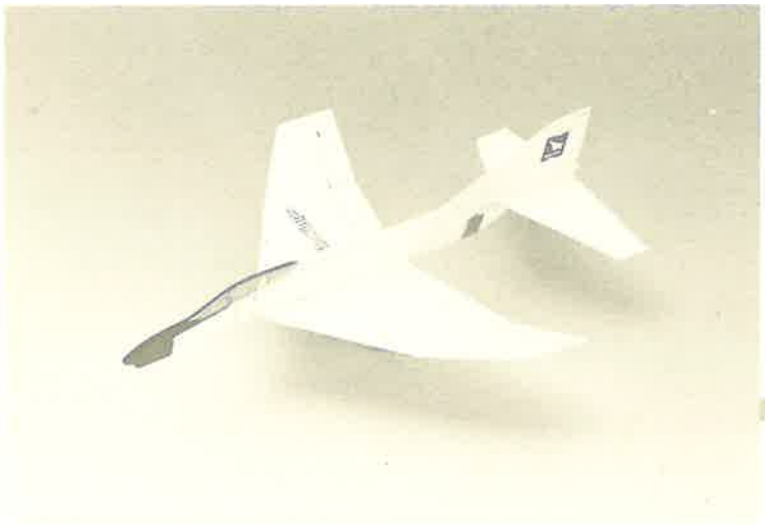

6
Cut along the solid lines up
to the dashed line
White wings
2
7
Cut along the solid lines up
to the dashed line
3
1
5
4







Whitewings®

McDonnell Douglas PHANTOM II

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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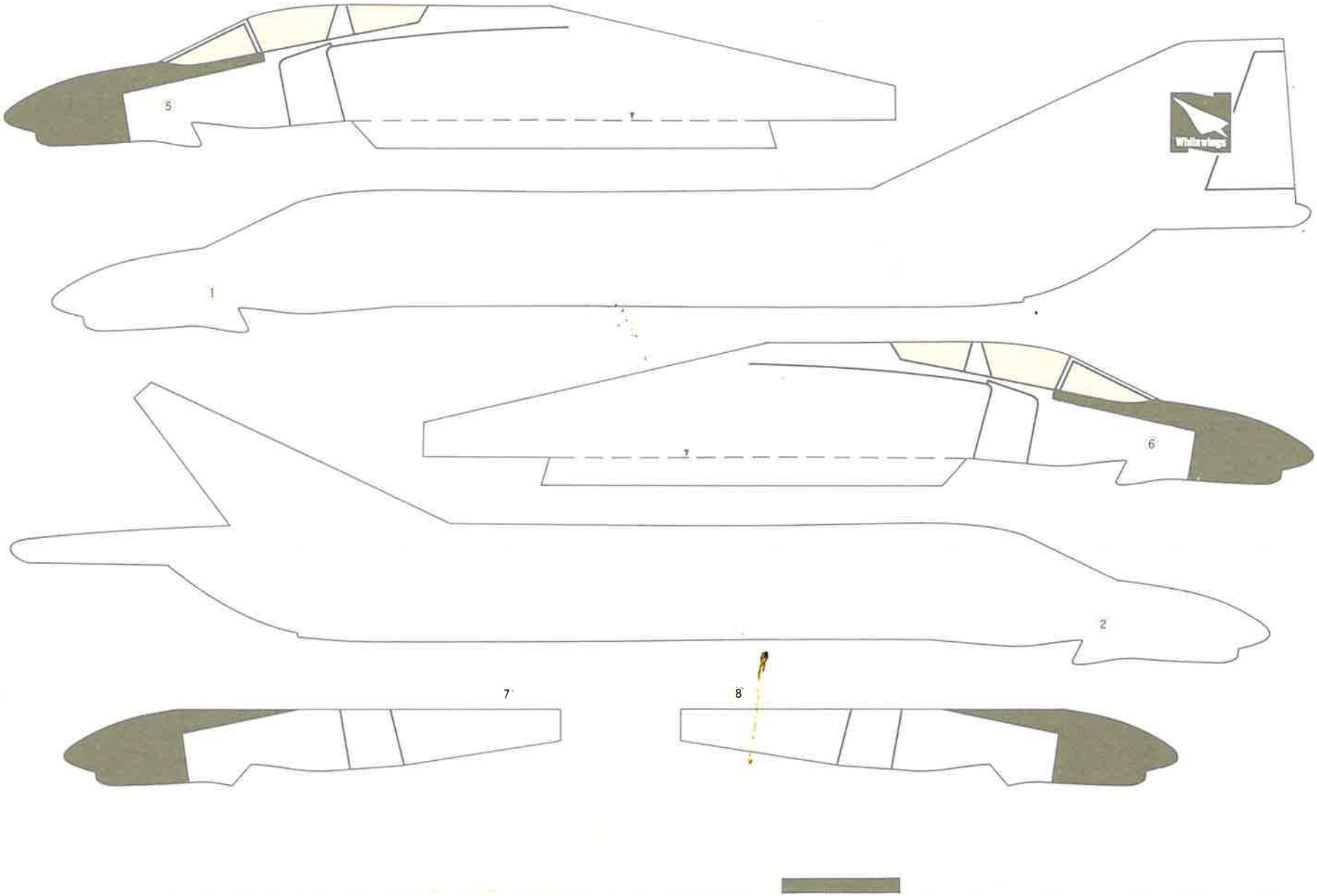
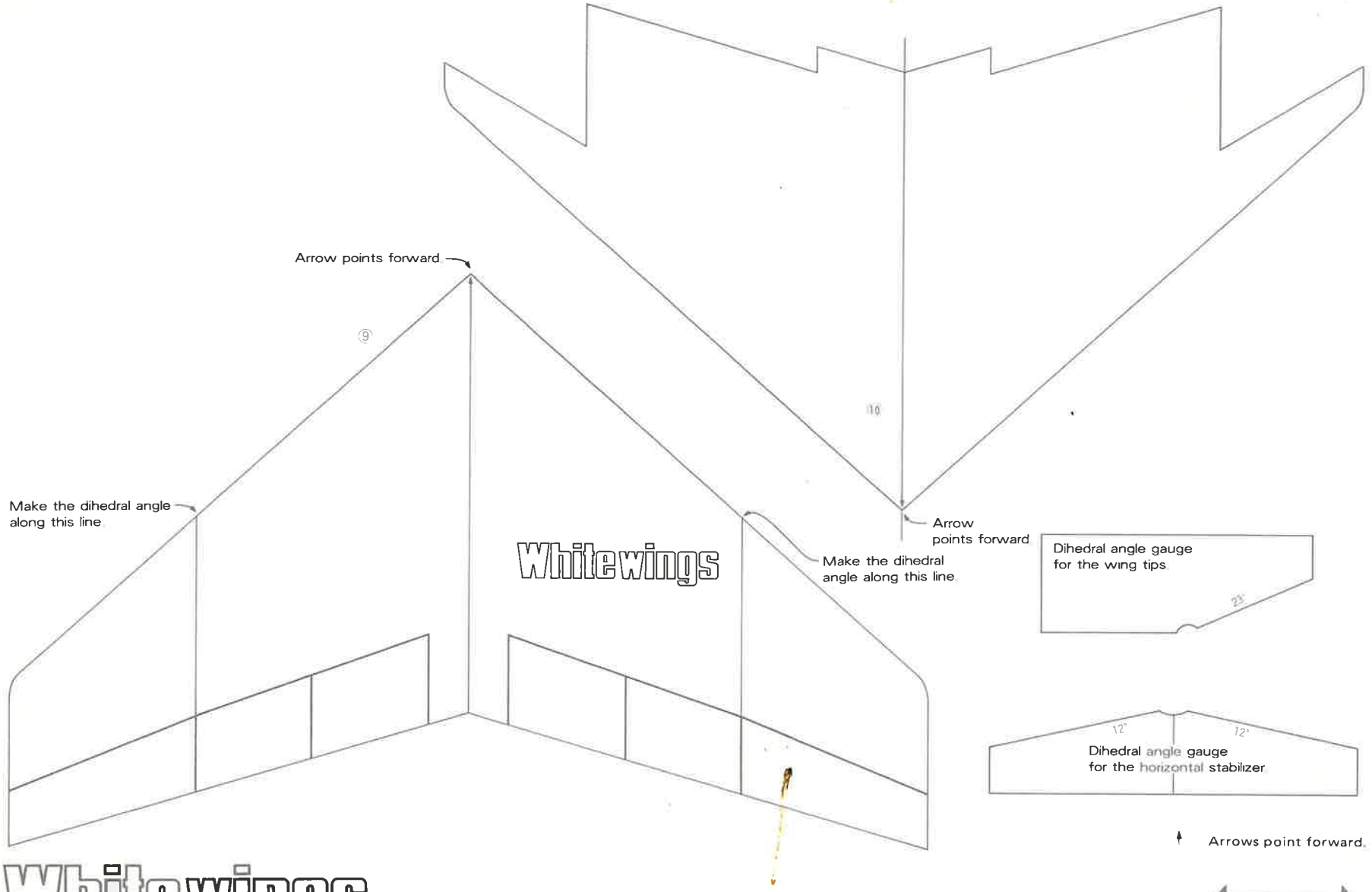

5
1
6
2
7
8



Whitewings® McDonnell Douglas PHANTOM II

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⑩

Arrow points forward.

Whitewings

⑨

Strega

Arrow points forward.

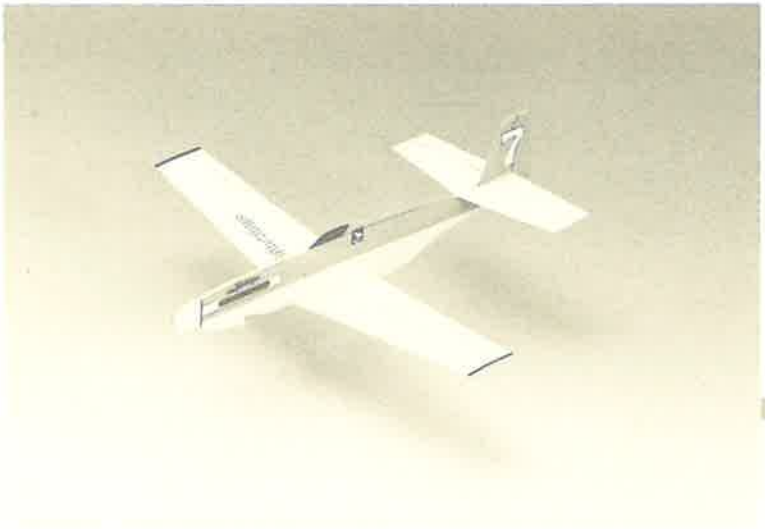
⑪

⑧

Strega

Arrow points forward.

⑫



Whitewings®

"STREGA" (Modified P-51 MUSTANG)

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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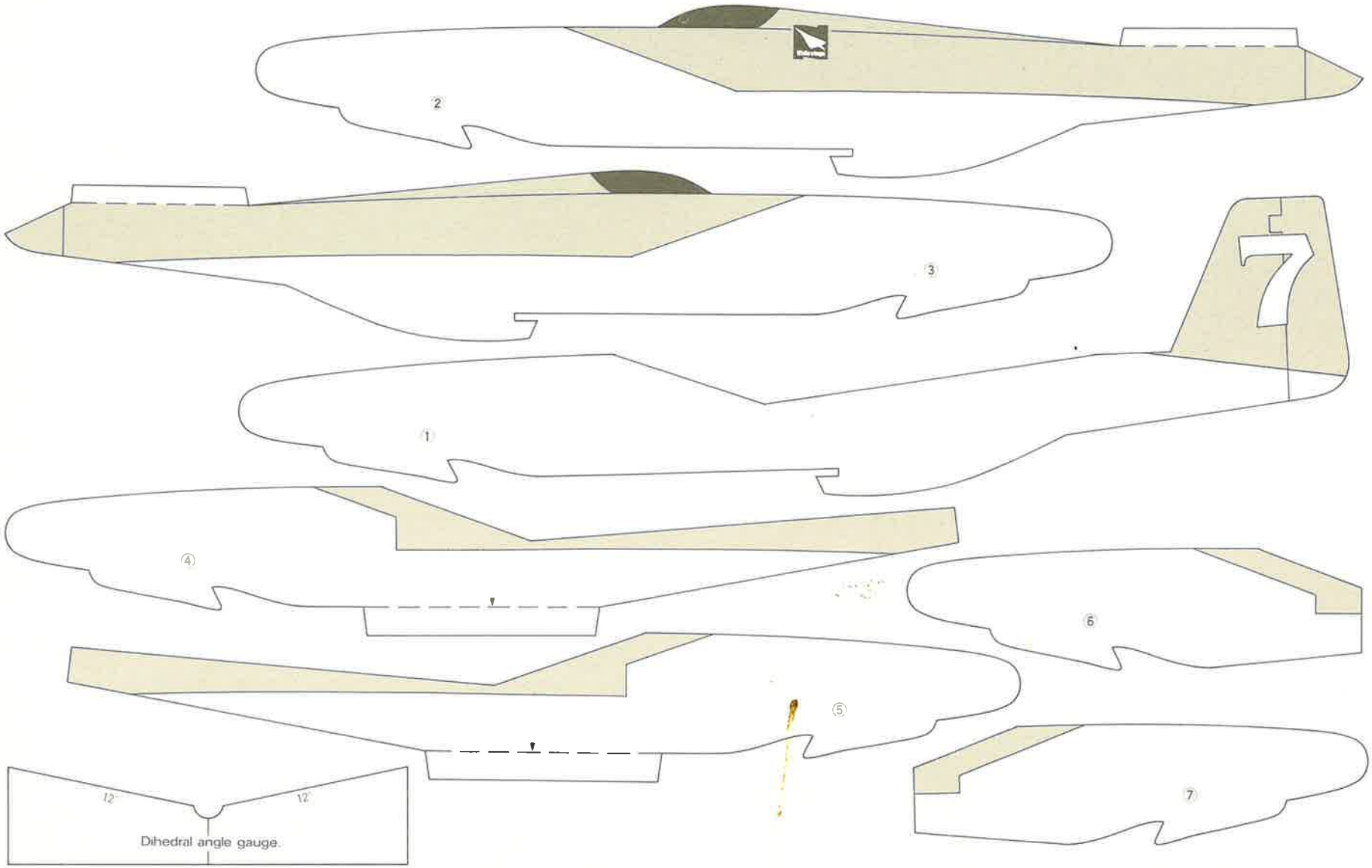
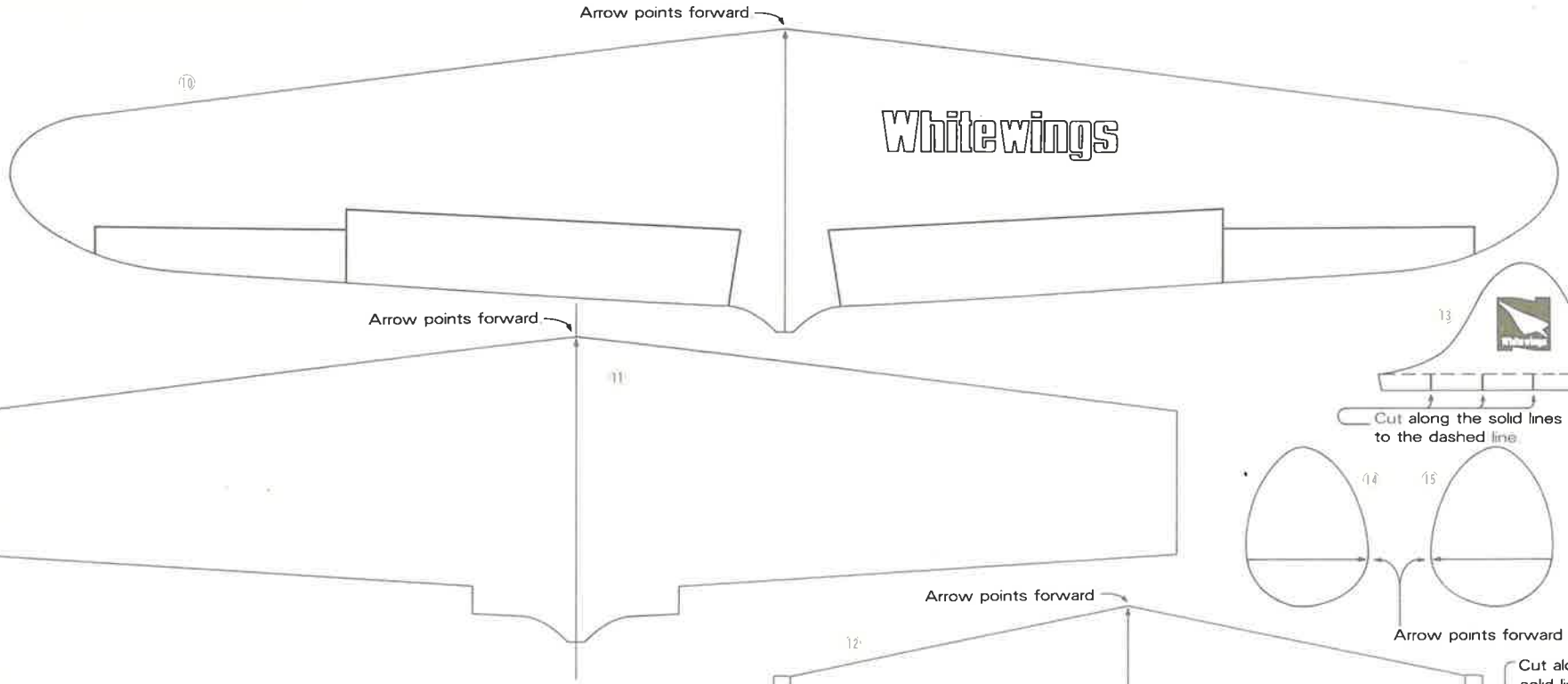
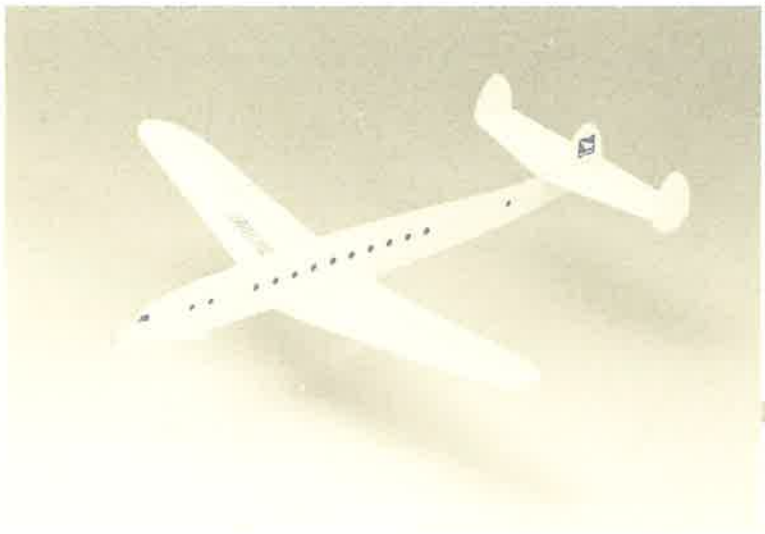

2
3
7
1
4
6
5
7
12°
12°
Dihedral angle gauge.





Whitewings®

Lockheed CONSTELLATION

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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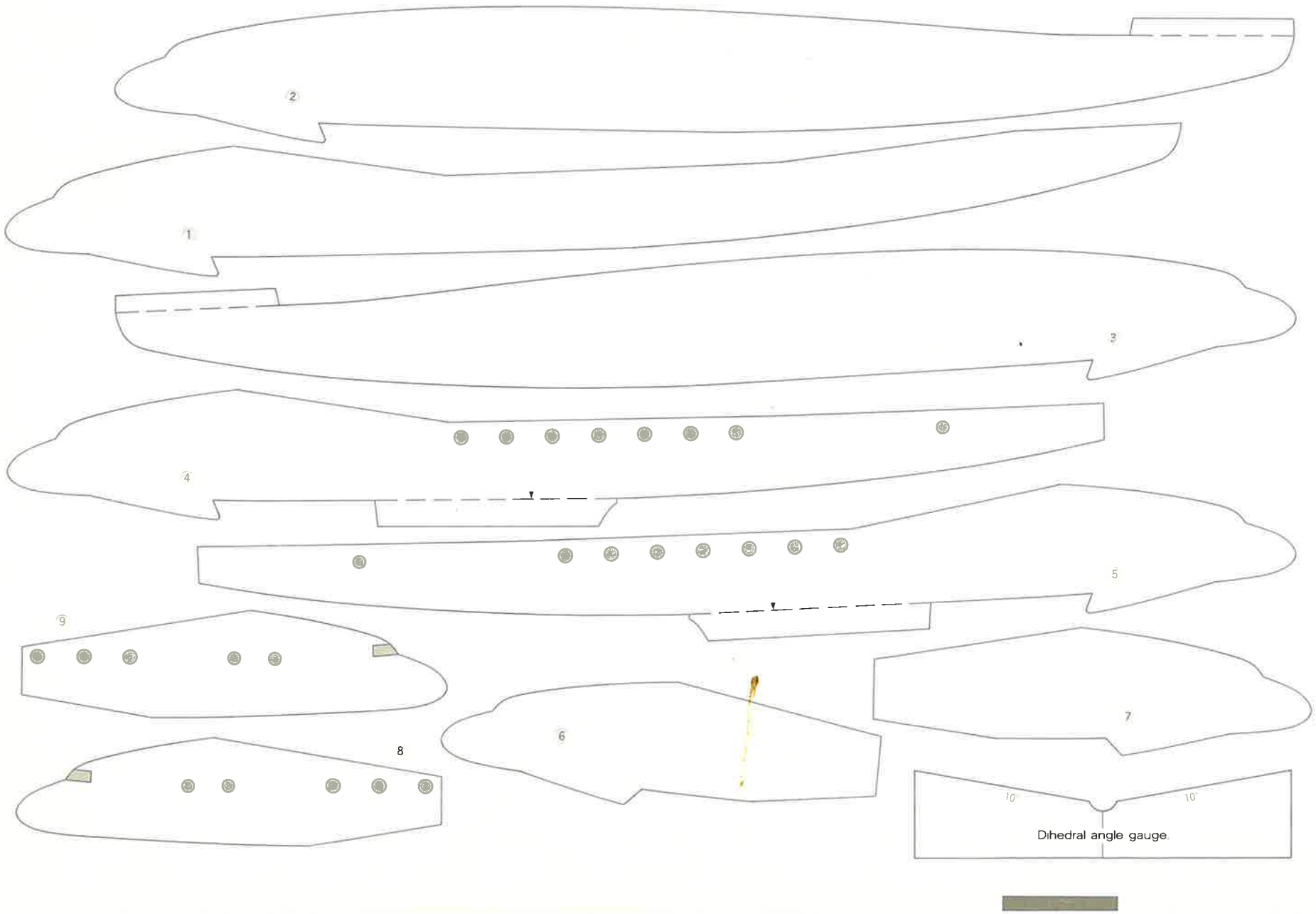
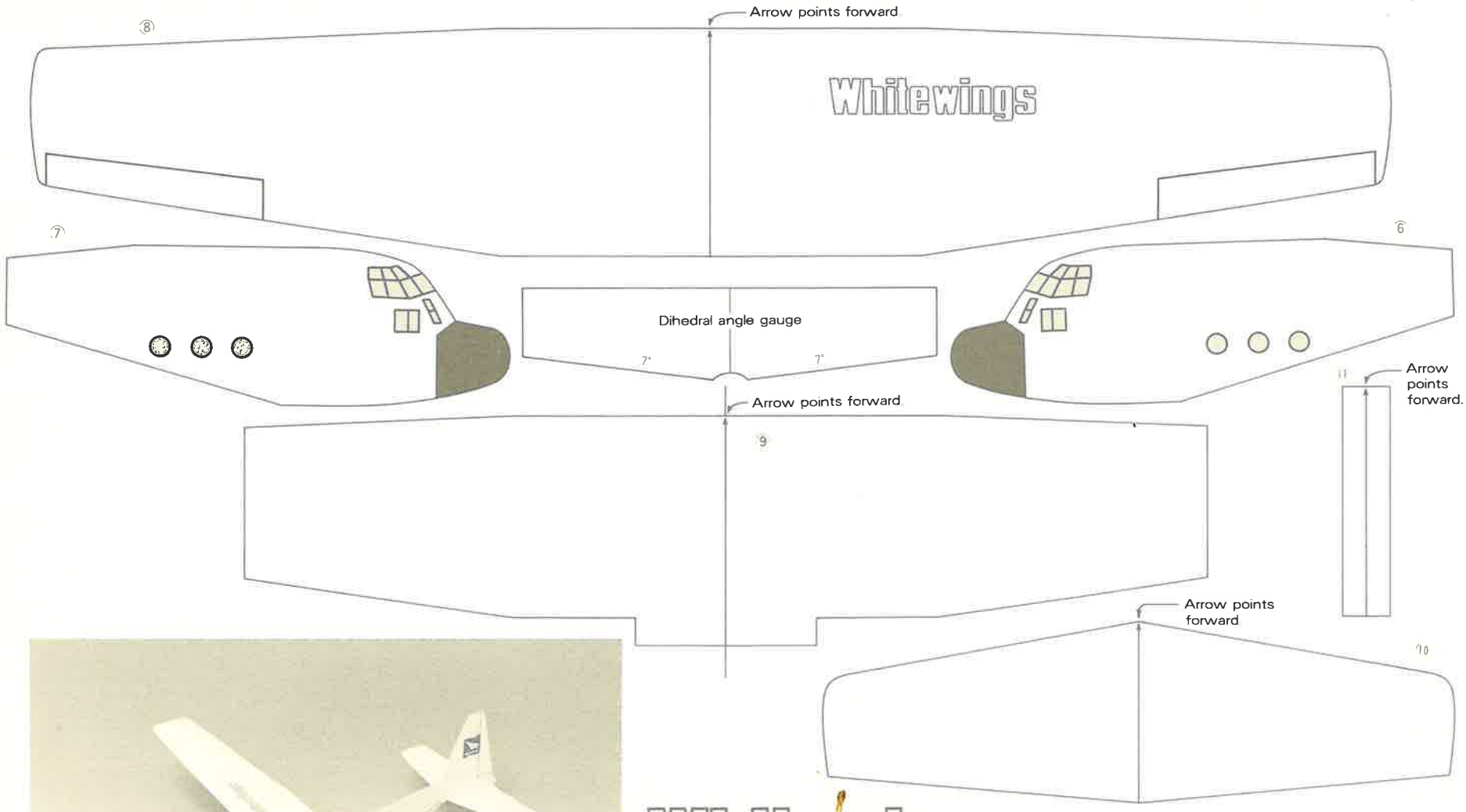
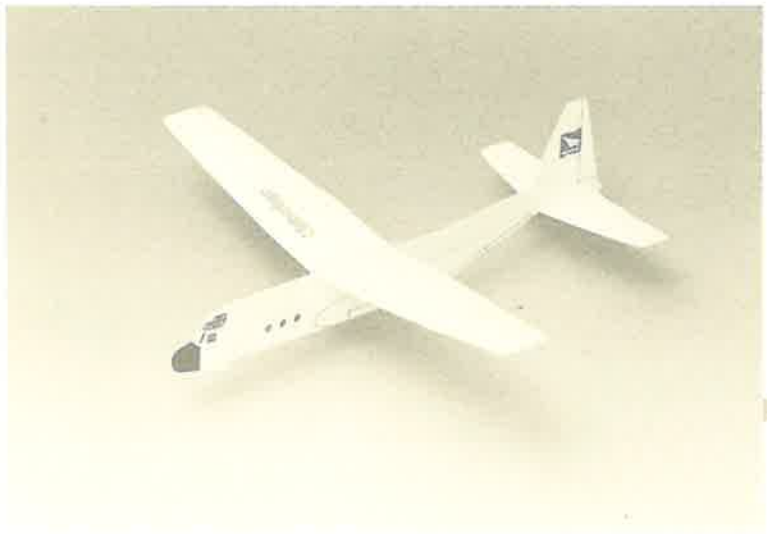

2
1
3
4
5
9
6
7
8
10
10
Dihedral angle gauge





Whitewings®

Lockheed C130 HERCULES

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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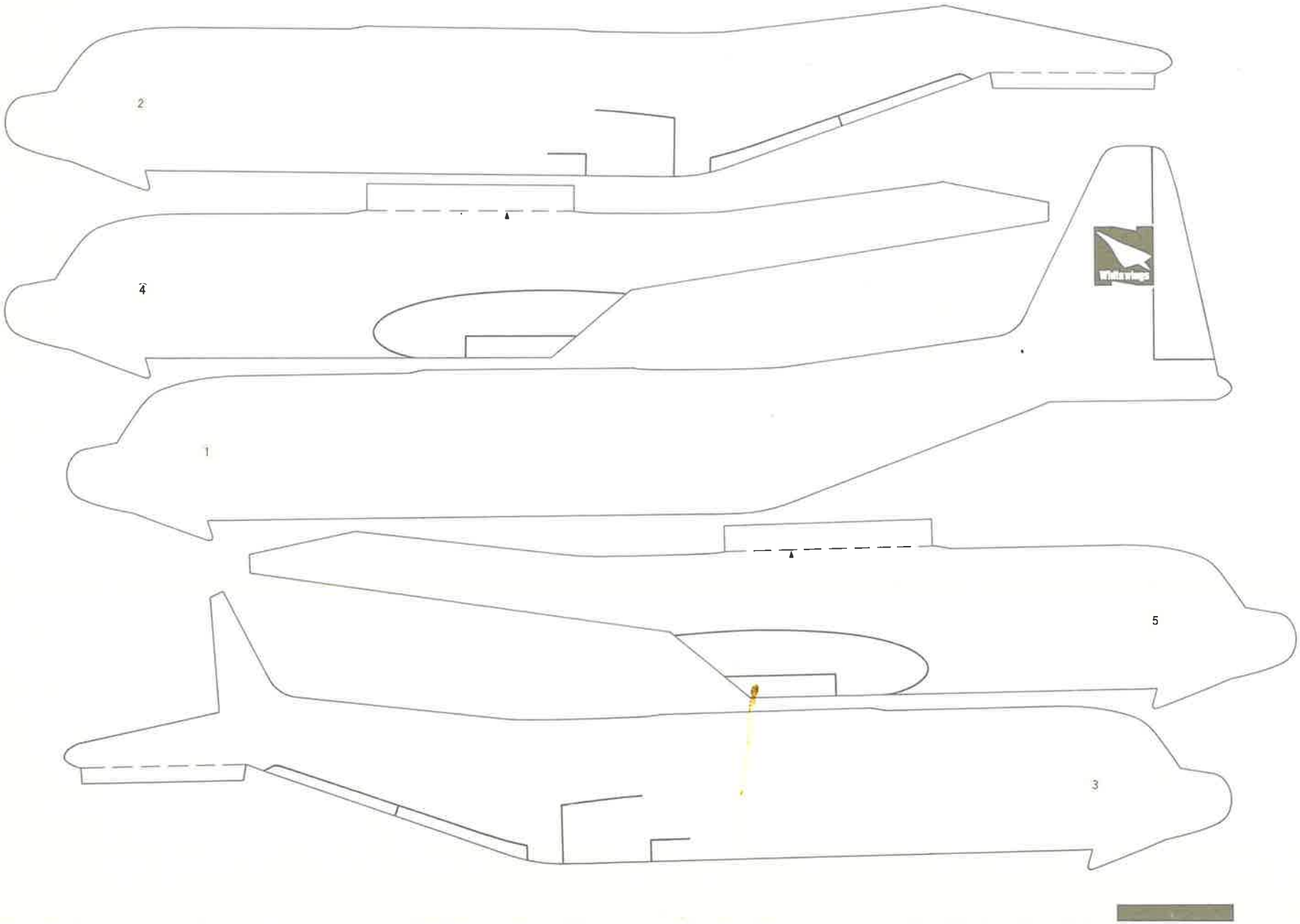
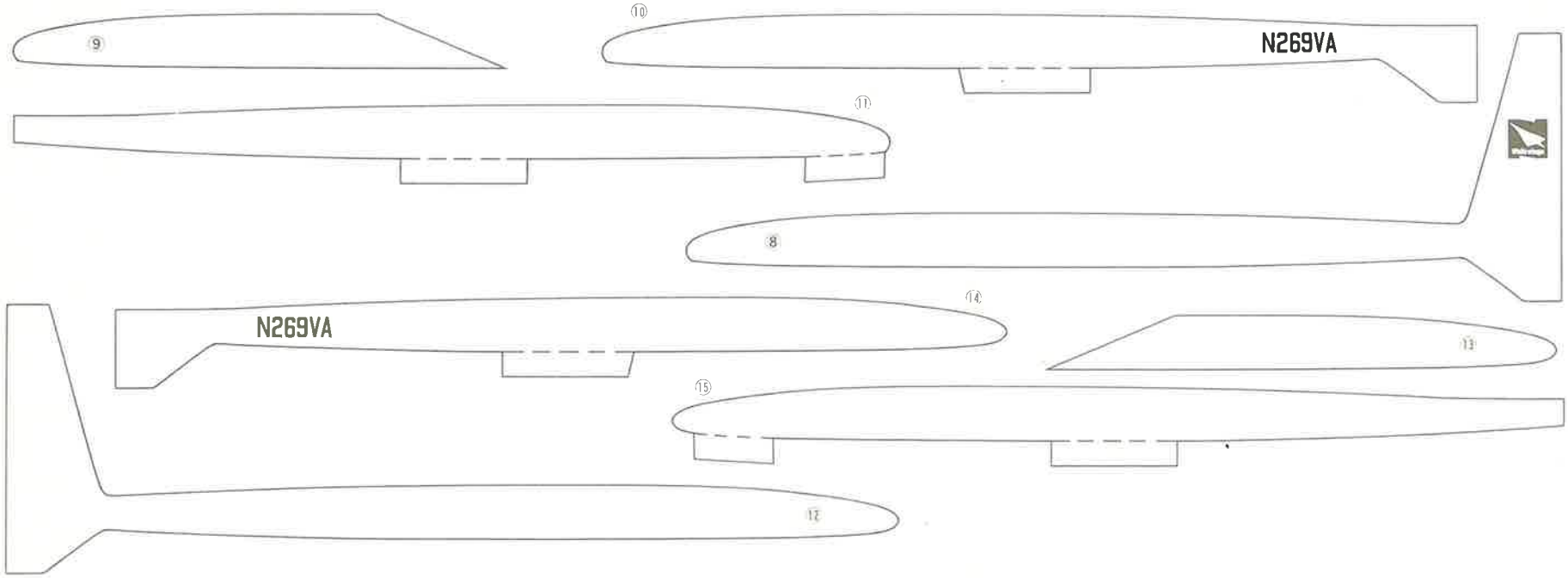
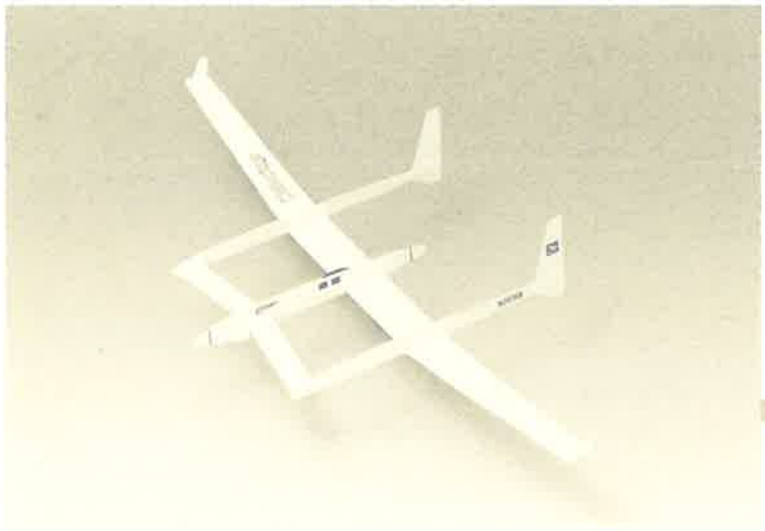

2
4
1
5
3





Whitewings®

"VOYAGER"

Fold with dashed line inside.
Arrows point forward.

Bend-resistant direction

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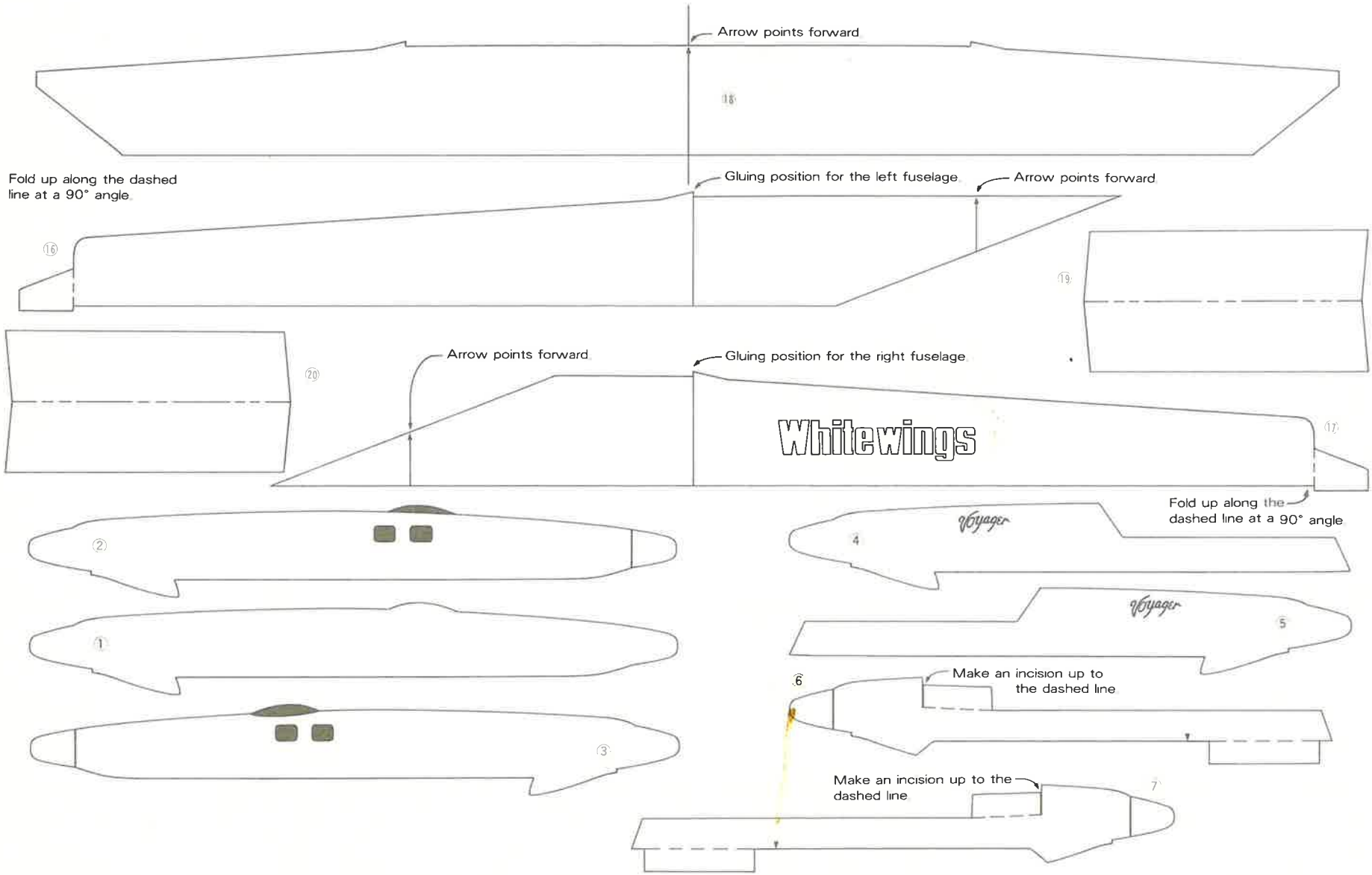
Arrow points forward
18
Fold up along the dashed line at a 90° angle
Gluing position for the left fuselage
Arrow points forward
16
19
20
Arrow points forward
Gluing position for the right fuselage
Whitewings
17
Fold up along the dashed line at a 90° angle
2
4
Voyager
Voyager
1
5
6
Make an incision up to the dashed line
3
Make an incision up to the dashed line
7